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A PRELIMINARY NOTE ON THE MANUFACTURE OF WOOD-TAR.

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Wood-tar is one of the products of the dry distillation of
wood, and is divided for market purposes
Introduction. into Wood-tar or broad leaf and Stockholm

or pine tar. The manufacture of Stockholm or pine tar is a well-established industry in Sweden, where "fat" or highly resinous wood is carbonized in kilns and the tar recovered, while all other products are neglected. Large quantities of Stockholm tar were annually imported into Calcutta before the War, as it is required in large quantities in jute mills for tarring ropes. Owing to foreign supplies of this article having been practically cut off, it has been suggested that a remunerative industry could be developed in the pine forests of India in order to meet the requirement of the jute mills of Calcutta. Experiments had, however, already been initiated by Mr. Canning in the Kumaun Circle with a view to utilizing twisted 'Chir' (*Pinus longifolia*) wood for this purpose and, at his request, similar experiments were carried out at the

Forest Research Institute, while the Punjab and Bengal Forest Officers are also considering the question of starting this industry.

"Stockholm tar" is essentially a very cheap varnish, consisting of resin, turpentine and tarry oils. Stockholm tar and its constants.

When allowed to settle, it deposits a granular crystalline matter consisting mainly of pyrocatechol. The British Pharmacopœia lays down the following characters and tests for Stockholm tar, officially termed *Pix Liquida*: "Dark brown or nearly black; semi-liquid; empyreumatic odour; heavier than water. Water shaken with it acquires a pale brown colour, sharp empyreumatic taste and acid reaction; very dilute T. Sol. of Ferric Chloride colours the solution red. Tar is completely soluble in ten times its volume of alcohol."

The following table gives the results of the comparative analysis of four samples of tar, two made by Mr. Canning and the writer by distilling the wood in retorts; a third prepared by Mr. Mathura Prasad Bhola, Divisional Forest Officer, Southern Garhwal Division, in a modified retort, and a fourth, Stockholm tar imported into Calcutta and received from Messrs. Bathgate & Co., Calcutta:—

	1 *	2	3 *	4
	Tar dried at 105°C. before analysis; received from Mr. F. Canning.	Retort tar made at Dehra Dun Forest Research Institute.	Tar received from Mr. Mathura Prasad Bhola. Dried at 105°C. before analysis.	Stockholm tar as imported.
Colour	Very dark brown.	Very dark brown.	Very dark brown	Dark brown.
Odour	Empyreumatic, smoky.	Empyreumatic, smoky.	Empyreumatic, smoky.	Empyreumatic, smoky.
Reaction	Acid	Acid	Acid	Acid.
Consistency	Semi-solid	Thick syrupy	Semi-solid	Semi-solid.
Solubility in 90% alcohol.	Completely miscible.	Completely miscible.	Completely miscible.	Completely miscible.
Specific gravity...	1.054	1.066	1.091	1.073
Light oil (up to 250°C.)	18.93 %	29.2 %	16.62 %	30.6 %
Heavy oil (up to 340°C.)	46.15 %	41.1 %	42.11 %	44.4 %
Pitch (black and brittle).	34.92 %	23.9 %	28.77 %	23.6 %

* These tars Nos. 1 and 2 had 20.1 and 12.50 per cent. of moisture and pyroligneous acid, respectively, as compared with 1.4 per cent. of the imported article.

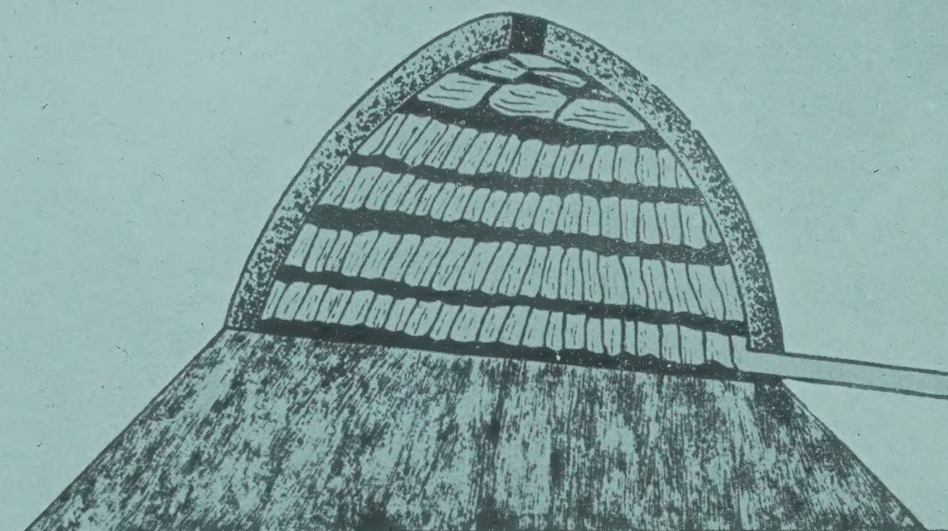


FIG (a)

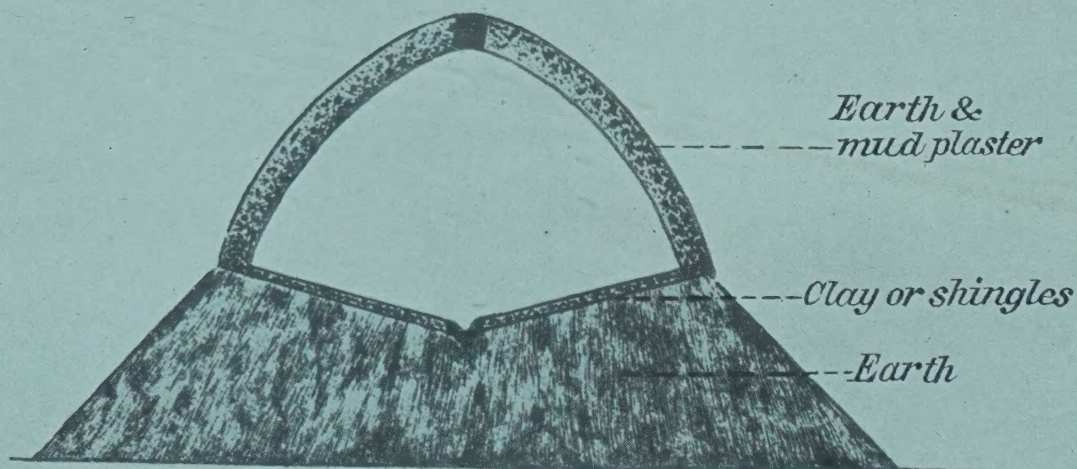
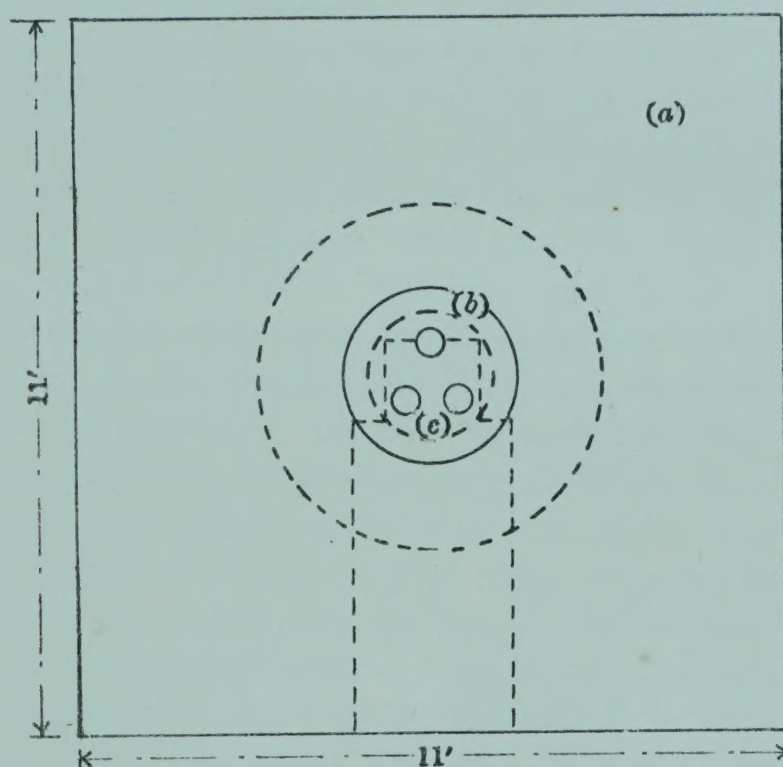


FIG (b)

A PRELIMINARY NOTE ON THE MANUFACTURE OF WOOD TAR.

EXPERIMENTAL KILN FOR PRODUCTION OF CHIR TAR ERECTED AT UKHALLEKH WEST ALMORA DIVISION.

Scale—1 Inch = 4 Feet.



PLAN.

- (a) Stone and Lime Mortar Masonry
- (b) Stone Lid
- (c) Draught Holes

(d)
(e)
(f)
(g)

As already mentioned, "Stockholm" tar is generally made in Sweden, Russia and other places, by burning highly resinous wood in various forms of kilns with special bottoms to drain off the tar from the wood which is being carbonized. The wood is cut into small pieces and is stacked in layers as shown in Plate 5, Fig. (a). As the wood burns and heat is developed in the kiln, the tar runs to the bottom and drains down the slopes of the V-shaped trough at the bottom of the kiln, shown in Fig. (b).^{*} In these kilns, the bottom is covered with shingles in order to get clean tar, free from dirt and dust. The fire is lighted at the bottom and the vapours escape at the top, as the fire progresses from the sides to the middle of the kiln. It is stated that it generally takes many days before the tar commences to run, and considerable quantities of charcoal are burnt up in the process. It is thus evident that the kiln process is only suitable for the treatment of very "fat" pine woods; and even then the yield of tar is much less than when the wood is treated in closed retorts on account of the combustion of a portion of the tar itself in the kiln. This point has been further confirmed by the experiments carried out in the field by Mr. F. Canning and also by the writer at the Forest Research Institute. Mr. Canning made a kiln of the type sketched in Plate 6, which yielded no tar. The writer employed a vertical double-walled kiln in which the draught was properly regulated, with negative results, only crude pyroligneous acid being collected. The kiln made on the Swedish model with a galvanized iron sheet bottom was also tried without success. The reason for this is, no doubt, that the wood used had only 5.72 per cent. of tar as determined by distilling it in a copper flask in the laboratory.

It seems almost impossible to convert "lean" wood into tar by the kiln process, though there is no doubt that a portion of the tar is recoverable by this process from "fat" wood. The chief merits of the kiln process are that large quantities of wood can be treated without much initial outlay on plant, while it does

^{*} Both figures (a) and (b) are taken from the "Utilization of Wood Waste by Distillation," by W. B. Harper.

not involve transport of machinery from place to place as the fellings advance through the forest; the disadvantages in the process consist in the loss of most of the charcoal while recovering the tar, and in the loss of tar itself when dealing with "lean" wood.

The Retort process is simple and very easy to carry out.

The Retort process.

The still used at the Forest Research Institute and with which the experiments detailed below were carried out, is shown in Plate 7. It consists of a still made of ordinary thick iron sheets (though for commercial purposes, the still should be made of thick cast-iron such as is generally used in the dry distillation of wood and oil) with a trap-still between it and the condenser, the still being surrounded by a furnace, provided with a chimney.

The process of operating the still is as follows:—

The still is charged with split billets and gradually heated up to dull red heat; as distillation proceeds, the tar fumes are condensed in the trap-still and the pyroligneous acid's vapours pass on and are condensed in the condenser shown in the sketch. As tar should be free from moisture and pyroligneous acid, it is advisable to catch the tar in such a trap whatever be the form of the still employed. Tar was prepared in a plant admittedly by no means perfect by the writer at the Forest Research Institute and, when taken out of the trap-still, was packed direct for commercial valuation without any further treatment. The Forest Economist, who sent the sample to a Calcutta jute firm, obtained the following report which is highly encouraging:—

"Our Mill Department are quite certain this tar will suit our purpose."

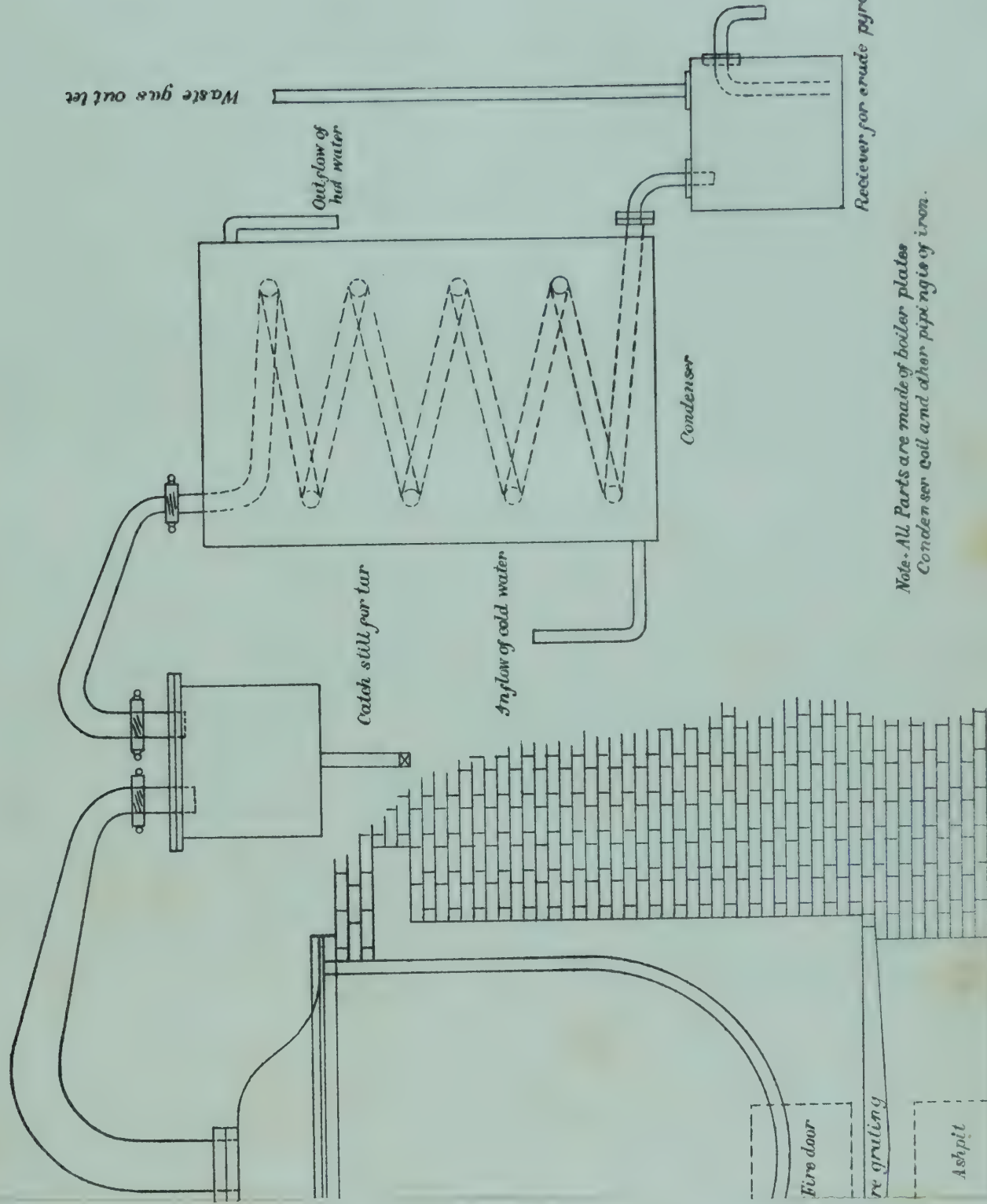
The retort used by Mr. F. Canning is sketched in Plate 8.

Mr. F. Canning's experiments.

The tar obtained in this retort is of standard constants and consistency except that it has an excess of moisture and pyroligneous acid, which, as stated above, can be obviated by working with a delivery pipe fitted on the top of the retort and by leading the tar vapours into a trap-still.

WOOD TAR STILL

Scale $\frac{1}{16}$ Full Size



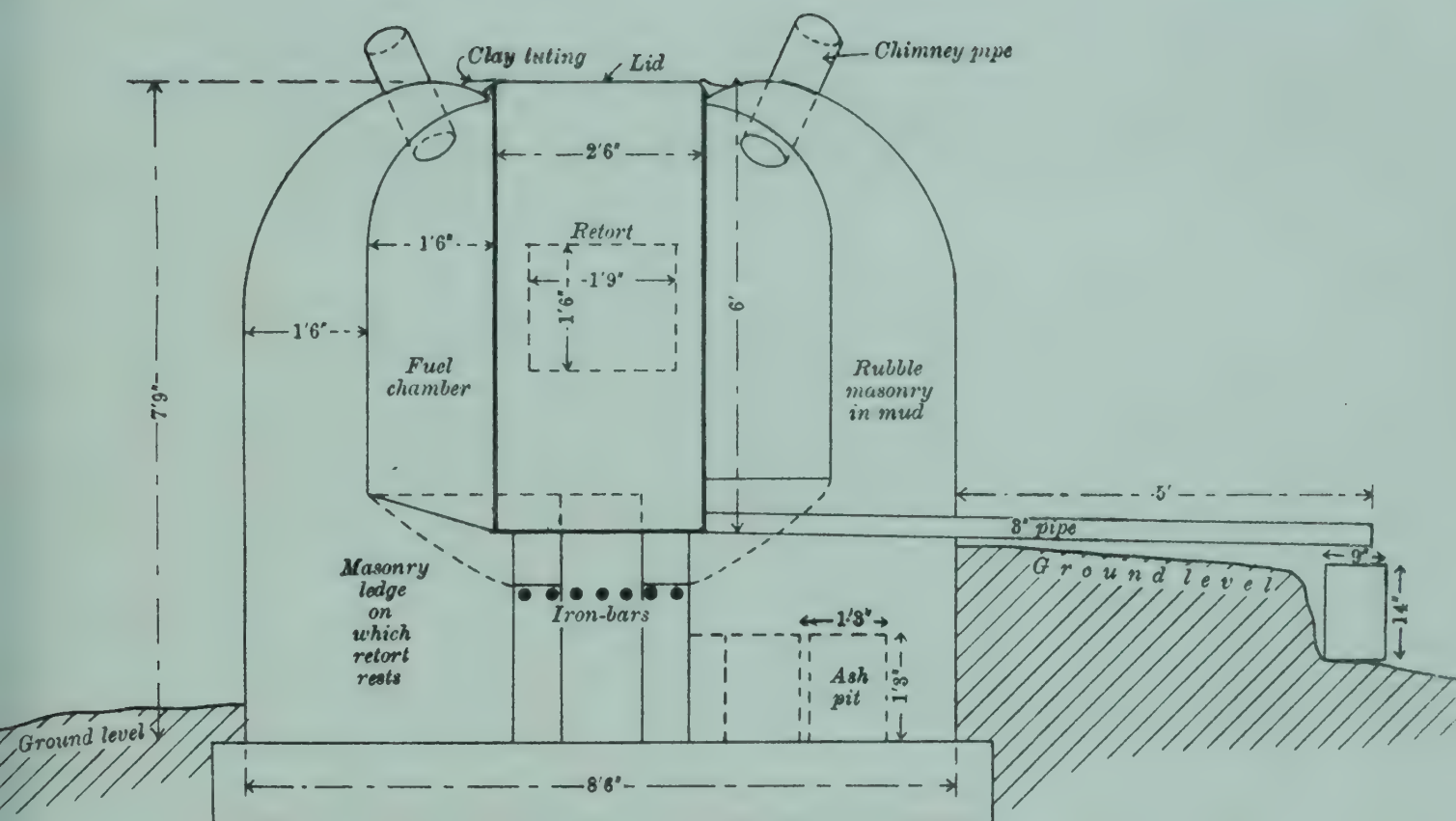
Note. All Parts are made of boiler plates
Condenser coil and other piping of iron.

PLANT FOR MANUFACTURE OF CHIR TAR

AT

KHAJURI, WEST ALMORA DIVISION.

Scale—1 Inch = 3 Feet.



It is difficult to give any figures of yield, as they depend on the quality of the wood employed for the purpose. As stated by Allen in his Commercial Organic Analysis, the yield is 7.10 per cent. of the wood, while from analysis of the Chir wood, which was afterwards treated in retorts at the Forest Research Institute by the writer, the yield of tar was 5.72 per cent on the weight of the wood. On the other hand, Mr. Canning, in one of his experiments, when treating very resinous wood, obtained as much as about 25 per cent.

Mr. Walters, Working Plan Officer, Kangra, submitted samples of twisted Chir wood which yielded the following percentages, when treated in the plant as shown on Plate 7:—

	Per cent.
The tar collected in the trap-still	... 6.77
Crude pyroligneous acid	... 25.13
As regards the market price of "Stockholm tar," a quotation dated 24th August 1917 is Rs. 125 per barrel of $2\frac{1}{2}$ to $3\frac{1}{2}$ cwt.	
Market rates for Stockholm tar.	

In order to see whether the tar distilled from the Himalayan oak would serve the purpose for tarring ropes, a charge of oak wood received also from Kangra was distilled in the same plant, with the following results:—

	Per cent.
The tar collected in the trap-still	... 1.04
The tar recovered from the condensed liquids	... 1.00
Crude pyroligneous acid	... 21.6
Charcoal	... 26.2

The yield of tar is extremely low, and would in itself not justify distillation unless there was also a good demand for oak charcoal. Broad-leaf tar does not fetch the same price as Stockholm tar; on the other hand, the charcoal is far superior to that obtained from pine wood, especially when prepared in retorts, so that it will very likely be found profitable to prepare it in this way

and, at the same time, recover the tar. The tar, as obtained from the trap, was sent to Calcutta by the Forest Economist for valuation, and the report received states that it is quite as suitable for their purpose as the pine tar.

This indicates that any wood tar would be equally suitable for the purpose of tarring ropes, and a field for the utilization of such waste materials as saw-dust of teak and other broad-leaf woods is thus opened up.

The Sal (*Shorea robusta*) wood obtained for fuel purposes from the Siwalik Division containing 11 per cent. of moisture was distilled and 27.6 per cent. of charcoal, 4.4 per cent. of tar and 31 per cent. of crude pyroligneous acid was obtained.

The wood of *Mallotus philippinensis* obtained from the Siwalik Division containing 48.02 per cent. of moisture was distilled and 20.45 per cent. of charcoal, 1.76 per cent. of tar and 35.45 per cent. of crude pyroligneous acid was obtained.

The wood of *Odina Wodier* obtained from the Siwalik Division containing 59.14 per cent. of moisture gave 19.20 per cent. of charcoal, 1.17 per cent. of tar and 34.37 per cent. of crude pyroligneous acid.

In this connection, it may be of interest to give the results of analysis of a sample of wood-tar prepared by a crude retort-method (the retort being an earthen pot), from the wood of "*Erythroxylon monogynum*," kindly sent by the District Forest Officer, Kollegal District, Coimbatore:—

	Per cent.
Specific gravity at 27°C.	1.079
Moisture and pyroligneous acid	12.96
Light oil (up to 250°C.)	13.02
Heavy oil (up to 340°C.)	54.24
Pitch	19.78
Phenolic bodies	16.8

These results show that it is an excellent sample of wood tar in heavy oils. Its well-known medical properties, for which it is so

highly prized by the local people, are no doubt due to the high percentage of "phenols" that it contains.

Conclusions.

The conclusions arrived at from this enquiry may be briefly stated as follows:—

- (1) That the tar obtained by distilling twisted "Chir" pine wood in retorts is of the same quality as the imported "Stockholm tar."
- (2) The kiln process of manufacturing "Stockholm tar" is not suitable for distilling "lean" wood, while even when dealing with a rich resinous wood the yield is less from a kiln than from a retort.
- (3) If transport is difficult, then a battery of portable retorts fitted with tar traps only is advocated. If, on the other hand, moving the plant involves no great difficulty and if there is likely to be a sale for crude pyroligneous acid, the necessary condensers for catching the pyroligneous acids and leading the undensifiable gases back to the furnace may also be included.
- (4) Should the conditions of distillation cause the tar traps to become very hot they must be kept cool by a wrapping of wet gunny bags or some such similar arrangement.
- (5) The "Chir" charcoal, when not marketable in any quantity, may be used as fuel for heating the retorts.

METHOD OF WORKING BAMBOOS.

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Experimental plots to ascertain the best system of working *Dendrocalamus strictus* bamboos were laid out by Mr. R. S. Troup in 1910, and have been examined in detail annually since.

The variations in method under experiment have been:—

- (1) Rotation: (a) Cutting the bamboos annually.
- (b) Do. do. every second year.
- (c) Do. do. every third year.
- (d) Do. do. every fourth year.

(2) Proportion of bamboos cut :

In the 1- and 2-year rotation clumps—

- (a) Cutting all bamboos except the new shoots of the current year.
- (b) Cutting half the bamboos except the new shoots of the current year.

(3) Height of cutting :

- (a) Cutting the bamboos above the first node, *i.e.*, close to the ground.
- (b) Cutting the bamboos above the third node.
- (c) Do. do. do. fifth do.

Note.—In no clumps were new shoots of the previous rains cut.

Mr. Troup selected two localities in the United Provinces, the one dry and the other comparatively damp. Ranipur, in the Siwaliks Division, is the dry locality, and Kotdwara in Lansdowne Division, the damp locality.

At Ranipur 3 clumps, and at Kotdwara 5 clumps, not adjoining each other but distributed over the experimental plot, were subjected to each variation of the experiment.

Of recent years, the bamboos in these localities had been worked under a 3 years' rotation, all culms except the shoots of the current year being cut. Thus, at the time the experiment started no culms were more than two rains old.

Before beginning work in the experimental plots, all clumps were thinned of dead and imperfectly developed culms.

SUMMARY OF RESULTS.

Rotation—1 year.

At Ranipur. After 8 years, removing annually all culms except new shoots, out of 9 clumps 4 are dead and 5 are producing only switches. Difference in height of cutting has had no effect.

At Kotdwara. After 8 years, removing annually all culms except new shoots, out of 15 clumps 11 are dead, 2 have produced no shoots this year and are in hopeless condition, 2 are failing.

At Ranipur. After 8 years, removing annually half the number of culms except new shoots, out of 9 clumps 4 are producing only switches, 5 are in fair condition. Difference in height of cutting has had no effect. During the 8 years, the 5 clumps in fair condition now have produced per annum an average of—
5.3 culms, mean length 15.7 ft., centre-girth 2.1 inches.

At Kotdwara. After 8 years, removing annually half the number of culms except new shoots, out of 15 clumps 7 are in good condition, 8 are poor or bad. Difference in height of cutting has had no effect. During the 8 years, these 15 clumps have produced per annum an average of—
3.2 culms, mean length 19.7 ft., centre-girth 2.8 inches.

Rotation—2 years.

At Ranipur. After 8 years, removing every second year all culms except new shoots, out of 9 clumps 1 has flowered and died, 3 are dead from overworking, 1 is producing only switches, 1 is producing much shorter culms, 2 are producing shorter and thinner culms, 1 is in good condition. Difference in height of cutting has had no effect. During the 8 years, the 4 clumps still productive have yielded an average per annum of—
5.8 culms, mean length 20.0 ft., centre-girth 2.6 inches.

At Kotdwara. After 8 years, removing every second year all culms except new shoots, out of 15 clumps 2 have flowered and died, 4 are dead from overworking, 1 is in good condition, 8 are poor or bad. Difference in height of cutting has had no effect. During the 8 years, the 9 clumps still alive have produced an average per annum of—
2.4 culms, mean length 22.5 ft., centre-girth 2.7 inches.

At Ranipur. After 8 years, removing every second year half the number of culms except new shoots, out of 9 clumps 1 is dead and 1 is producing only switches, 3 are producing shorter culms but are otherwise in fair condition, 4 are in good condition. Difference in height of cutting has had no effect.

During the 8 years, the 7 clumps still productive have yielded an average per annum of—

3.6 culms, mean length 20.6 ft., centre-girth 2.5 inches.

At Kotdwara. After 8 years, removing every second year half the number of culms except new shoots, out of 14 clumps 1 has flowered and died, 10 are in good condition, 1 fair and 2 poor. Difference in height of cutting has had no effect. During the 8 years, the 13 clumps alive have produced an average per annum of—

2.6 culms, mean length 24.1 ft., centre-girth 3.0 inches.

Rotation—3 years.

At Ranipur. After 6 years, removing every third year all culms except new shoots, all 9 clumps are in good condition; they have produced an average per annum of—

Cutting at a
height of—

3.8 culms, mean length 19.5 ft., centre-girth 2.7 inches...1 node.

4.9 culms, mean length 20.0 ft., centre-girth 2.7 inches...3 nodes.

5.4 culms, mean length 22.2 ft., centre-girth 2.9 inches...5 nodes.

At Kotdwara. After 6 years, removing every third year all culms except new shoots, out of 15 clumps 1 has flowered and died, 2 are dead from overworking, 3 are in good condition, 2 fair, and 7 poor or bad. Difference in height of cutting has had no effect. During the 6 years, the 12 clumps alive have produced an average per annum of—

2.4 culms, mean length 23.7 ft., centre-girth 3.1 inches.

Rotation—4 years.

At Ranipur. After 8 years, removing every fourth year all culms except new shoots, all clumps are in good condition; they have produced an average per annum of—

Cutting at a
height of—

2.8 culms, mean length 21.0 ft., centre-girth 2.6 inches...1 node.

5.3 culms, mean length 20.0 ft., centre-girth 2.5 inches...3 nodes.

5.0 culms, mean length 20.0 ft., centre-girth 2.5 inches...5 nodes.

At Kotdwara.—After 8 years, removing every fourth year all culms except new shoots, out of 15 culms 2 have flowered and died, 6 are in good condition, 3 fair, and 4 poor. Difference in height of cutting has had no effect. During the 8 years, the 13 culms alive have produced an average per annum of—

3.2 culms, mean length 28.1 ft., centre-girth 3.1 inches.

FURTHER OBSERVATIONS.

Rate at which stumps of felled culms dry up.—It has been stated that the stumps of felled culms dry up at the rate of one internode a year. Repeated observations record that the topmost internode of the stump is dry generally after one year, but not always. In many cases, the rest of the stump remains green for 3 or more years. The rate at which the stump dies is irregular and may depend on the vigour of the clump, the treatment to which the clump has been subjected, and the season of cutting. In some cases, the whole stump remains green for years, and this is the case whether side-shoots have been sent out at the nodes or not; in some cases, the whole stump dries up in one year, and this is common in clumps severely overworked. It is rare for the whole stump to dry up gradually; when this occurs, the rate is very slow.

Effect of heavy rain upon production of new shoots.—The 1916 rains were heavier than usual, and the new shoots of this year were taller and thicker than those of the previous 6 years. More shoots were produced than usual, while some clumps which were almost dead revived and sent out new shoots. But the 1917 rains were still heavier, and the new shoots were only average in number and quality.

Vitality of culms.—It was observed at Kotdwara in November 1916 that the culms of 1909 were undoubtedly drying up, and those of 1910 too to some extent; culms of 1911 doubtful, some drying up, some still green; culms of 1912 all green. This suggests that here a rotation of more than 4 years might lead to some culms drying up before they are felled, causing a decrease in their value, and that a rotation of 6 years or more would be very risky.

Effect of cutting all culms including new shoots.—At Ranipur in December 1911 three clumps were clear-felled at a height of one foot from the ground. They contained :—

Old culms.	New shoots.	Length.	Centre-girth.
9	8	22'	2'7"
4	3	19'	2'5"
10	5	26'	2'9"

In December 1912, all 3 clumps were alive and had produced a number of bushy and some whip-like shoots. The bases of more than half the culms cut had dried up completely. In January 1916, the first clump had produced 8 whippy culms, the other two were quite dead.

At Kotdwara, in January 1913, three clumps were clear-felled. They contained :—

Old culms.	New shoots.	Length.	Centre-girth.
18		25'	2'4"
9		32'	3'7"
22		37'	4'1"

In November 1913, the three clumps had produced 2, 1 and 3 slender new shoots in addition to a number of short switches.

In 1914 each clump had put out one more thin new shoot.

In 1916 the first clump contained two whip-like culms $\frac{1}{4}$ " thick ; the second clump contained three culms $\frac{3}{4}$ " thick ; and the third clump contained six culms up to $\frac{3}{4}$ " thick.

In 1917 the first clump was dead, the second had 3 old culms and one new, the third 6 old culms and one new, but all thin.

Clear-felling part of a clump has a tendency to kill that part of the clump.

Removal of all culms except new shoots causes the new shoots to bend over owing to lack of support.

Season of cutting.—If bamboos are cut in September and dragged out of the clump, the new shoots are often bent, because they are still soft. From this aspect it would appear desirable to defer cutting bamboos as late as practicable before the next rains

Among other points, the risk of danger from fire and the possibility of completing extraction during the open season would have to be considered.

Lignification.—New shoots lose their sappy softness and become hard certainly before they are 15 months old, and probably after 9 or 10 months. In January, culms 18 months old are very difficult to distinguish by eye from those 30 months old.

Flowering.—Clumps often flower partially. At Kotdwara, clump No. 91 flowered in 1912 but one thin new shoot appeared in 1913. All the old culms except one of 1912 flowered and died, but the new culm of 1913 is thriving. The same observation was made elsewhere in Paniali Block, old culms flowering and dying, while new shoots appear amongst them green and healthy.

Cutting culms below ground-level.—This has been stated to affect the vitality of the rhizomes and to produce congestion in the clump. Of five clumps treated thus on a 3-year rotation, one flowered, one died, and the other three are in poor condition after 8 years. This method seems bad.

CONCLUSION.

(It should be noted that these conclusions refer only to *Dendrocalamus strictus* in the United Provinces.)

1. Annual working, whether cutting high or cutting low, whether removing all old culms or only half of them, leads to more or less rapid reduction in size of clump, in number of new shoots, and in girth of culms.

2. When all the culms except those of the current year are cut, the clump deteriorates. This is true for 1-year, 2-year and 3-year rotations, and for cutting at a height of one node, three nodes, or five nodes. When the rotation is 4 years, this result is not so obvious.

3. When the rotation is one year and only half the number of old culms is cut, the results are better than when all old culms are cut. Height of cutting makes no difference. Of 15 clumps treated thus, only two were in good condition, and this method cannot be recommended. When only half the old culms were cut, the clumps

under a 2-year rotation were in much better condition than those under a year rotation.

4. Whatever the rotation, some old culms should be left. Old culms are wanted both for the mechanical support of new shoots and to maintain the rhizomes in full vigour.

5. The effect of difference in height of cutting upon the health of the clump is either *nil*, or so slight as to be negligible. Cutting high produces a number of twigs at the top of the stumps which impedes working.

Production of new shoots is not affected by height of cutting. But removing half the old culms gives more shoots than clear-felling all old culms, and 2-year rotation more than 1-year rotation. Of the methods under experiment, most new shoots were yielded by the clumps worked under a 2-year rotation when half the number of old culms were felled. Felling all the old culms fails to produce many new shoots even when the rotation is four years. But a 3-year rotation, some of the old culms being left standing, would probably give better results than a 2-year rotation.

Clear-felling all culms, including shoots of the current year nearly, but not quite, kills the clump. After four rains the clumps are beginning to look up again, and shoots $\frac{3}{4}$ " thick to arise. Repeating the complete cutting of all culms without exception for two consecutive years would here probably kill most clumps.

GENERAL REMARKS.

To work these bamboos economically, it would appear that in every clump some old culms must be left standing. A 2-year rotation leaving half the old culms may be better than a 3-year rotation felling all the old culms. But a 3-year rotation leaving some old culms would very likely be better still.

A system of working bamboos may be based on the size of the clump, on the number of new shoots produced, or on a minimum number of old culms to be left standing. But the system must be one which admits of easy check. If a proportion of the old culms is laid down as the standard, it is, in practice, difficult to check whether too many culms have been felled or not. In

the Punjab this method has been adopted, and I understand that it cannot be strictly enforced though it is said to work well in practice. Similarly, any rule prescribing a minimum number of old culms to be left based on the number of new shoots is practically unworkable.

It would be simpler to fix a minimum number of old, sound culms at least one inch thick, which must be left in each clump. But clumps vary in size. So the average size of clumps in the locality must be ascertained. If the average clump contains 20 old culms, and the rotation is 3 years, a minimum of seven old culms per clump might be fixed.

Another problem is the distribution within the clump of the culms left standing. Clear-felling part of a clump is liable to kill that part of the clump; so the culms left standing should be distributed evenly over the clump.

While a fully-stocked clump produces more shoots than a severely worked clump, there seems ground for the belief that if kept in an open condition more shoots will arise than if allowed to become congested. Loosening the earth and heaping it up round the base of a clump is likely to stimulate the sprouting of new buds.

Where bamboos have been worked continuously for years, it might be highly beneficial to give the clumps a period of rest for 3 or 4 years before introducing a new method of treatment.

Year of observation.	Serial number of clump.	Number of bamboos cut.	Mean length.	Mean centre-girth.	Number of new shoots.	Serial number of clump.	Number of bamboos cut.	Mean length.	Mean centre-girth.	Number of new shoots.	Serial number of clump.	Number of bamboos cut.	Mean length.	Mean centre-girth.	Number of new shoots.	Serial number of clump.	Number of bamboos cut.
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Rotation—1 year. Proportion of culms cut—

At Ranipur.

1910	...	1	2	16	2'9	...	18	1	16	2'4	...	37	1	14	2'6	...	1	3	
1911	...	...	4	18	3'4	8	...	10	22	3'4	2	...	4	28	3'3	0	...	5
1912	...	...	8	17	2'2	6	...	2	21	2'6	4	...	0	...	...	...	...	3
1913	...	...	6	17	2'4	5	...	6	20	2'1	8	...	0	...	...	...	...	3
1914	...	...	5	14	2'2	5	...	8	18	2'6	6	...	1	6	1'2	...	...	3
1915	5	16	2'0	3	...	6	19	2'4	3	...	Dead				2
1916	...	...	1	Switch.	...	0	...	3	17	2'2	2	...	...	...	...	...	...	3
1917	...	...	...	Dead.	...	...	...	2	9	1'6	1	...	...	...	...	...	...	2

Rotation—1 year. Proportion of culms cut—

1910	...	3	7	16	2'4	...	21	1	16	3'4	...	43	0	...	...	...	3	2
1911	...	...	2	21	2'5	13	...	5	26	3'9	3	...	6	28	3'3	5	...	3
1912	...	...	13	15	2'2	5	...	3	23	3'0	4	...	5	16	2'4	7	...	1
1913	...	...	5	17	2'0	5	...	4	22	2'8	3	...	7	19	2'4	4	...	2
1914	...	...	5	12	1'8	4	...	3	24	3'0	4	...	4	20	2'5	3	...	1
1915	...	...	4	13	2'0	2	...	3	19	2'6	3	...	3	20	3'0	4	...	1
1916	...	...	2	Switches	...	0	...	1	19	3'2	0	...	1	19	2'9	2	...	0
1917	...	...	0	Switches	...	...	...	...	Dead	...	...	...	2	14	1'0	1	...	...

Rotation—1 year. Proportion of culms cut—

1910	...	5	0	...	...	...	20	3	13	3'6	...	49	0	...	...	...	5	2
1911	...	...	6	20	3'0	2	...	6	22	2'8	4	...	7	22	2'6	0	...	3
1912	...	...	2	15	2'2	1	...	4	19	1'4	3	...	0	...	...	...	...	1
1913	...	...	1	16	2'2	1	...	3	17	2'0	2	...	2	11	1'1	6	...	1
1914	...	...	1	14	2'0	0	...	2	15	2'0	1	...	6	11	1'9	7	...	1
1915	...	...	0	...	...	...	...	1	11	1'9	1	...	7	11	2'0	4	...	0
1916	...	...	0	...	...	2	...	1	Switch	...	...	...	4	18	2'8	4	...	0
1917	...	...	2	11	1'8	0	...	...	Dead	...	...	...	4	14	1'2	0	...	...

Mean length.
Mean centre-girth.
Number of new shoots.
Serial number of clump.
Number of bamboos cut.
Mean length.
Mean centre-girth.
Number of new shoots.
Serial number of clump.
Number of bamboos cut.
Mean length.
Mean centre-girth.
Number of new shoots.
Serial number of clump.
Number of bamboos cut.
Mean length.
Mean centre-girth.
Number of new shoots.
Serial number of clump.
Number of bamboos cut.
Mean length.
Mean centre-girth.
Number of new shoots.

All except new shoots. Height of cutting—Above 3 nodes.

At Kotdwara.

9	2'4	...	19	3	11	2'5	...	37	5	19	4'1	...	55	2	13	3'6	...	73	1	20	3'6	...
12	1'7	3	...	4	20	2'0	2	...	1	27	2'5	4	...	3	12	1'8	2	...	1	15	2'4	4
16	2'3	3	...	2	27	2'5	1	...	4	20	2'3	2	...	2	16	2'0	2	...	4	18	2'6	6
15	2'0	3	...	1	20	2'1	1	...	2	20	1'9	4	...	2	14	1'9	3	...	6	20	2'5	1
11	2'4	2	...	1	15	3'2	1	...	4	15	2'5	2	...	3	12	1'8	2	...	1	12	3'6	1
20	2'6	2	...	1	27	3'2	1	...	2	24	2'6	3	...	2	19	2'0	1	...	1	20	2'8	1
20	2'4	2	...	0	...	...	...	...	3	23	3'1	3	...	1	12	2'0	1	...	1	16	2'3	1
11	2'0	0	...	...	Dead	...	...	...	3	29	3'0	1	...	...	Dead	...	...	...	1	18	1'9	0

All except new shoots. Height of cutting—Above 3 nodes.

11	3'1	...	21	2	13	2'7	...	39	3	15	2'9	...	57	2	21	4'3	...	75	2	17	3'3	...
10	2'9	1	...	2	20	2'2	3	...	2	16	2'8	2	...	4	20	3'5	3	...	4	8	3'8	0
16	2'1	2	...	3	15	2'0	1	...	2	18	1'0	1	...	3	24	2'0	4	...	0	...	...	3
16	1'8	1	...	2	15	2'0	2	...	3	8	1'0	3	...	4	24	2'6	4	...	3	16	1'5	1
10	3'6	1	...	2	16	2'2	2	...	2	12	1'3	1	...	3	16	2'6	1	...	1	16	1'9	1
16	1'8	0	...	2	21	2'2	1	...	0	...	...	...	...	1	24	3'2	1	...	1	16	1'5	0
...	...	...	...	1	20	2'7	0	...	4	11	1'0	0	...	1	17	1'9	0	...	0	...	...	...
Dead	...	...	...	Dead	...	...	...	...	...	Dead	...	...	...	...	Dead	...	...	...	...	Dead	...	...

All except new shoots. Height of cutting—Above 5 nodes.

9	2'3	...	23	2	17	3'3	...	41	4	10	2'0	...	59	4	16	3'0	...	77	3	21	4'0	...
10	2'8	1	...	2	18	1'6	2	...	1	12	1'0	1	...	6	10	2'2	4	...	2	12	3'6	5
13	1'9	1	...	2	14	'9	2	...	1	13	'8	1	...	4	17	1'2	6	...	2	16	1'8	2
12	1'7	1	...	2	14	1'4	2	...	1	15	2'0	1	...	3	15	1'8	1	...	2	20	1'9	2
14	2'4	1	...	2	18	1'9	4	...	1	24	2'2	0	...	1	12	1'5	0	...	2	20	3'0	2
...	...	...	...	1	14	1'9	0	...	0	...	...	1	...	0	...	...	1	...	2	16	2'0	0
...	...	...	...	0	...	...	2	...	0	...	...	0	...	0	...	...	...	...	0	...	...	0
Dead	...	...	...	0	...	...	0	...	...	Dead	...	...	...	...	Dead	...	...	...	...	Dead	...	...

Year of observa- tion.	Serial number of clump.	Number of bamboos cut.	Mean length.	Mean centre-girth.	Number of new shoots.	Serial number of clump.	Number of bamboos cut.	Mean length.	Mean centre-girth.	Number of new shoots.	Serial number of clump.	Number of bamboos cut.	Mean length.	Mean centre-girth.	Number of new shoots.	Serial number of clump.	Number of bamboos cut.
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Rotation - 1 year. Proportion of culms cut—

At Ranipur.

1910	...	2	2	13	2'1	...	19	0	40	0	2	1
1911	2	20	2'5	6	...	6	24	3'2	5	...	3	21	2'5	0	...	2
1912	...	...	6	11	'8	5	...	6	10	1'0	2	...	1	15	2'0	0	...	2
1913	...	...	5	16	2'0	5	...	4	20	2'2	7	...	0	...	...	...	...	1
1914	...	...	5	15	2'0	7	...	5	22	2'7	4	...	2	11	1'6	3	...	2
1915	...	...	5	14	2'4	8	...	4	25	2'5	2	...	2	15	1'9	0	...	2
1916	...	...	7	18	2'3	5	...	4	18	2'7	5	...	2	Switches		2	...	2
1917	...	...	4	20	2'6	7	...	3	21	2'6	4	...	1	Switch.		1	...	2

Rotation—1 year. Proportion of culms cut—

1910	...	4	2	14	2'4	...	23	0	...	...	...	46	0	...	...	...	4	1
1911	...	...	4	21	2'5	8	...	2	18	2'7	4	...	4	21	2'5	1	...	2
1912	...	...	5	10	'8	12	...	3	15	2'0	2	...	2	20	2'0	5	...	2
1913	...	...	9	15	2'1	11	...	2	14	1'2	3	...	2	14	1'5	6	...	3
1914	...	...	10	14	2'0	6	...	2	13	1'6	0	...	4	18	2'0	2	...	3
1915	...	...	8	14	2'1	12	...	2	19	2'5	1	...	3	19	2'4	1	...	5
1916	...	...	11	15	2'4	8	...	1	...	...	2	...	3	17	2'6	3	...	6
1917	...	...	9	17	2'1	7	...	1	16	2'1	1	...	2	14	1'2	4	...	4

Rotation—1 year. Proportion of culms cut—

1910	...	6	0	...	...	...	22	1	11	1'6	...	52	0	...	...	...	6	2
1911	...	...	2	18	3'2	3	...	5	19	3'0	8	...	4	24	2'9	0	...	2
1912	...	...	3	15	1'6	7	...	7	13	2'0	12	...	0	...	...	2	...	2
1913	...	...	5	17	2'3	3	...	9	17	2'0	12	...	1	10	'9	4	...	3
1914	...	...	4	17	2'5	7	...	10	17	2'0	6	...	2	10	1'6	1	...	3
1915	...	...	4	16	2'3	6	...	7	15	2'2	4	...	1	11	1'8	3	...	4
1916	...	...	6	18	2'6	4	...	7	17	2'8	10	...	3	...	...	2	...	2
1917	...	...	6	13	2'2	4	...	8	16	2'0	6	...	1	8	1'0	1	...	5

Year of observation.	Serial number of clump.	Number of bamboos cut.	Mean length.	Mean centre-girth.	Number of new shoots.	Serial number of clump.	Number of bamboos cut.	Mean length.	Mean centre-girth.	Number of new shoots.	Serial number of clump.	Number of bamboos cut.	Mean length.	Mean centre-girth.	Number of new shoots.	Serial number of clump.	Number of bamboos cut.
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Rotation—2 years. Proportion of culms cut—

At Kotdwara.

1911	...	7	12	23	3'3	25	38	5	25	3'1	3	38	6	25	2'7	0	7	3
1913	...	...	40	22	2'5	9	...	7	19	2'1	1	...	Dead	...	...	...	...	2
1915	...	...	12	19	3'0	10	...	2	2'1	2'4	0	...	...	...	...	...	...	2
1917	...	...	14	18	2'3	6	...	Dead	...	...	...	...	...	...	...	...	...	2

Rotation—2 years. Proportion of culms cut—

1911	...	11	6	30	4'0	12	24	9	26	3'2	6	44	5	31	2'9	0	9	7
1913	...	...	19	20	2'6	7	...	10	20	2'4	8	...	7	20	2'0	3	...	10
1915	...	...	14	25	3'0	6	...	11	17	2'5	3	...	3	23	2'5	0	...	11
1917	...	...	2	18	2'6	0	...	5	16	2'2	3	...	8	11	2'8	5	...	7

Rotation—2 years. Proportion of culms cut—

1911	...	15	10	21	3'2	8	34	7	20	2'8	1	50	5	24	3'0	0	11	4
1913	...	...	16	16	1'8	6	...	2	14	1'9	2	...	0	...	...	2	...	3
1915	...	...	10	15	2'2	9	.	3	14	1'9	2	..	4	16	2'5	0	...	2
1917	...	...	12	18	2'5	7	...	2	Switches		0	..		Dead			...	2

Year of observa- tion.	Serial number of clump.	Number of bamboos cut.	Mean length.	Mean centre-girth.	Number of new shoots.	Serial number of clump.	Number of bamboos cut.	Mean length.	Mean centre-girth.	Number of new shoots.	Serial number of clump.	Number of bamboos cut.	Mean length.	Mean centre-girth.	Number of new shoots.	Serial number of clump.	Number of bamboos cut.
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Rotation—2 years. Proportion of culms cut—

At Ranipur.

1911	...	8	6	25	3'4	3	27	3	22	2'9	2	41	3	22	2'5	0	8	2
1913	...	...	6	18	1'9	10	...	4	21	2'0	3	...	Dead			...	...	5
1915	...	...	9	16	2'5	2	...	4	18	2'4	1	...	...	...	...	...	...	Flo-
1917	...	...	8	16	2'5	4	...	4	15	2'1	2	...	...	...	...	...	...	...

Rotation—2 years. Proportion of culms cut—

1911	...	12	7	21	2'9	25	32	3	23	2'8	6	47	3	30	2'7	0	10	3
1913	...	...	21	18	2'2	13	...	7	20	1'9	5	...	3	24	2'8	8	...	4
1915	...	...	17	19	2'5	7	...	8	21	2'4	5	...	3	18	2'6	0	...	3
1917	...	...	19	22	2'4	8	...	9	20	2'0	6	...	3	23	3'1	3	...	5

Rotation—2 years. Proportion of culms cut—

1911	...	16	3	20	2'6	0	35	3	26	3'3	2	53	3	33	2'9	0	12	1
1913	...	...	3	16	1'8	1	...	9	18	2'1	8	...	2	19	2'0	8	...	2
1915	...	...	2	13	2'3	1	...	9	19	2'8	4	...	6	18	2'4	5	...	4
1917	...	...	1	11	1'6	1	...	9	14	2'1	4	...	8	20	2'5	6	...	5

Year of observation.	Serial number of clump.	Number of bamboos cut.	Mean length.	Mean centre-girth.	Number of new shoots.	Serial number of clump.	Number of bamboos cut.	Mean length.	Mean centre-girth.	Number of new shoots.	Serial number of clump.	Number of bamboos cut.	Mean length.	Mean centre-girth.	Number of new shoots.	Serial number of clump.	Number of bamboos cut.
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Rotation—3 years. All cut except new shoots.

At Ranipur.

1912	...	9	9	27	3'2	1	25	15	25	3'4	6	39	5	14	2'1	6	13	7
1915	..	...	10	15	2'2	9	...	15	22	3'0	2	...	15	14	2'4	5	..	8

Rotation—3 years. All cut except new shoots.

1912	...	13	12	20	2'8	6	31	17	20	2'3	9	42	9	20	2'6	8	14	6
1915	...	...	12	20	3'3	5	...	23	19	2'5	1	...	15	20	2'6	3	...	7

Rotation—3 years. All cut except new shoots.

1912	...	17	10	22	3'8	5	29	20	23	2'6	20	45	8	22	2'4	6	15	5
1915	...	...	15	25	3'4	4	...	36	21	2'5	5	...	8	20	2'4	1	...	7

Rotation—4 years. All cut except new shoots.

1913	...	10	14	20	2'0	2	26	12	21	2'2	2	48	10	24	2'9	13	16	7
1917	...	..	4	20	3'0	1	...	4	20	2'5	1	..	15	20	2'9	2	...	7

Rotation—4 years. All cut except new shoots.

1913	...	14	22	20	1'9	3	33	15	19	2'2	9	51	22	24	2'9	13	17	13
1917	...	...	19	17	2'5	7	...	15	16	2'5	5	...	33	26	3'0	2	...	20

Rotation—4 years. All cut except new shoots.

1913	...	28	16	19	2'4	11	36	13	18	2'0	11	54	4	15	2'0	1	18	7
1917	...	...	31	19	2'7	8	...	19	22	3'0	9	...	4	17	1'2	1	...	12

At Kotdwara.

24	2'6	4	3'	3	14	4'0	1	19	16	23	3'0	4	67	11	19	2'3	5	85	6	16	3'0	1
27	3'4	3	...	3	24	2'7	1	...	17	29	3'5	6	...	9	26	3'0	3	...	5	25	2'8	3

Height of cutting—Above 3 nodes.

28 | 3'4 | 2 | 32 | 4 | 19 | 3'0 | 1 | 50 | 7 | 15 | 1'8 | 4 | 68 | 7 | 25 | 3'1 | 3 | 86 | 12 | 36 | 4'5 | 5
26 | 3'1 | 2 | .. | 4 | 21 | 2'4 | 4 | ... | 12 | 18 | 2'7 | 3 | ... | 6 | 29 | 3'6 | 1 | ... | Flowered

Height of cutting—Above 5 nodes.

26	3'0	3	33	6	18	3'2	2	51	4'27	2'8	5	69	7'26	3'0	8	87	9	17	4'0	2		
22	3'0	2	...	2	20	2'6	2	...	10	33	3'5	3	...	15	37	4'4	6	...	6	25	3'1	5

Height of cutting—Above 1 node.

30	2'8	2	34	24	32	2'5	10	52	6	24	3'0	2	70	21	28	3'2	4	88	17	25	4'0	5
37	4'4	1	...	27	30	3'6	6	...	3	25	2'4	1	...	Flowered	...	7	29	2'8	2			

Height of cutting—Above 3 nodes.

25	2'2	5	35	10	20	2'1	3	53	11	32	3'6	8	71	7	29	3'2	3	89	7	24	2'1	3
34	4'0	3	...	12	27	3'2	0	...	19	37	4'2	3	..	12	29	3'1	1	..	11	23	2'2	5

Height of cutting—Above 5 nodes.

16	2'6	3	36	7	20	2'1	2	54	11	37	2'6	5	72	6	26	2'8	4	90	14	28	3'0	5
32	3'6	3	...	6	26	3'0	1	...	23	38	3'8	4	...	Flowered	...	30	30	3'7	4			

NOTE ON THE SUPPLY OF HAY TO OUR FIGHTING FORCES ABROAD.

(Contributed.)

It is probably well known by now that some lakhs of tons of fodder are being exported overseas for the use of mounted troops, etc., in the zone of war, nor is it revealing a military secret to state that of the hay being despatched nearly one lakh of tons is being cut and baled in the Central Provinces in the present season. These provinces, including Berar, are in a good position to undertake this supply owing to the large amount of grass available, and the number of the cotton-presses which are found in the south-west of these provinces. A press worked by hand will reduce hay to a bale one-third or one-fourth of its original bulk. For short journeys by rail this is sufficiently convenient. A steam press again almost quadruples the carrying capacity of the wagon or ship; and, in these days of scarce freightage, it is important to make one steamer carry in steam-baled hay the quantity it would take more than three steamers to carry if it were only hand-baled. Bales turned out by hydraulic engines worked by steam are included in "steam-baled."

A 22-ton broad-gauge wagon will carry about $2\frac{1}{3}$ tons of hand-baled hay and eight tons of steam-baled hay.

A fortunate circumstance is the superfluity of these cotton-presses, wherever there are large towns in cotton districts on or near the Railway. The supply of these ponderous machines is far in excess of the demand, with the result that Trusts or Combines have been formed in each town to prevent cut-throat competition.

The owner of any new press set up in a pressing centre need not trouble to work it; he simply joins the Combine so that he gets a share of the pooled profits. The result is that there are almost invariably one or more silent presses available for pressing hay.

An English farmer would open his eyes if he saw the way hay is made in India. Instead of turning the grass constantly after cutting it, the Indian grass-cutter wastes half his time tying it into small bundles, and then leaves it lying on ground not infrequently in the shade to take its chance of drying, and nothing one can do will induce him to change this time-wasting method. It is certainly convenient for reckoning in a country where weights and measures are not standardized (witness the Bengal and Bombay maund, the one of 40 and the other of 28 seers). Weight is, moreover, easily made up with water, sand or stones.

One result of this method is that, except for small private supplies for one's own cattle, it is not sound to start cutting grass too early in the cold weather when dews are heavy and there is still a chance of a local shower. Water ruins grass much more effectively if half dry than if fully hayed.

As the unit of work is the coolie, so the unit of hay is the bundle or *poola* tied up with a wisp. The *poola* varies from a half to one and half pounds in weight and for purposes of military supply, where the ton is the unit, *poolas* of slightly over a pound (to allow for wastage) are aimed at. This enables us to approximate from the number of *poolas* cut how many tons we are dealing with. The *poolas* may be supplied direct to the hydraulic press where the lead is by road and does not exceed forty miles. If, however, the hay has to be delivered to the press by rail, it must be made more portable by being first hand-baled in the forest. This reduces the bulk of the grass by at least two-thirds.

There are some half a dozen or so different kinds of hand-presses varying from Rs. 500 to Rs. 1,200 in price.

These presses turn out bales of varying size and density but it can be taken as proved that like many other articles the more expensive presses are the cheapest in the long run. The writer is in favour of the Bijoli Press costing Rs. 1,200. This turns out a small very compact bale with great rapidity. These small bales pack best in closed wagons, their only disadvantage being that they take more lashing comparatively than larger ones, but as lashings are being returned from the steam presses this

drawback is immaterial. $3\frac{1}{2}$ tons of grass pressed in these small bales can be loaded into a truck which is where the saving comes in.

These presses are set up in or near the forest so that roads converging from the latter will meet at a convenient spot in relation to the railway station from which they are despatched to the steam hydraulic pressing centres.

The pressing of the bales in the hydraulic presses is interesting to anyone of a mechanical turn of mind. The grass is first stamped into a long iron box roughly four feet long, two feet wide and fourteen feet deep. A set of pistons or plungers now presses up a massive block of iron which exactly fits the long iron box until the fourteen feet of hay is pressed into a fairly solid wad about two feet thick. The blocks of iron top and bottom between which the hay is pressed are provided with deep grooves on their inner sides. Into these grooves, a huge double fork with a double set of prongs is pushed so that when the pressure is released the double fork swings out with a huge mouthful of pressed hay. The fork is now pushed into a more powerful press similar to the first but with only a short stroke and open back and front. As the lower block is forced up, the pressure on the fork becomes released and the fork is now swung out of the grooves empty and the hay compressed into slab only 15 inches thick. The grooves now permit of hoop iron, ties or wire-ropes being placed around the bale and tied as tightly as possible. The pressure is now released very gradually, the ropes or wire taking up the strain. While the tying up in the second press takes place, the coolies in the first press are filling up the deed box with a fresh load of hay. The filling and the tying being done by hand are very slow so that a lot of time is saved by these operations being carried out in two separate presses.

As at present arranged, the work of collection and delivery of the hay at the hydraulic presses or railway stations (in the case of baled hay) is done by the Forest Department.

On arrival at the press, the hay is taken over by the Civil Department who arrange for the pressing and the despatch of the completed bales to Bombay. It would probably have been better

if the whole work could have been done by one department; this was, however, rendered difficult owing to the want of sufficient supervising establishment.

As regards the work in the forest, the cutting and collection is usually done by contractors who are required to deliver the grass either at the hydraulic presses, or if the grass is delivered by rail to the nearest railway station in the form of hand-pressed bales. This method saves a good deal of trouble, as no cognizance is taken of the grass except as regards quality, until it arrives at the hydraulic press or railway station. Cases have, however, arisen when competent contractors were not obtainable and the work has to be done departmentally. Coolies have then to be paid individually on the basis of the number of *poolas* cut by them. It is usual to arrange for the *poolas* to be collected into small stacks of 2,000 odd *poolas* or one ton by the coolies under supervision. This can often be done by families or two partners working together. Carting is ordinarily not started until the stacking in any one locality is finished.

Some difficulty has been experienced with contractors, many of whom have never done grass work before, and rates have had to be fixed for them on a fair basis. The same applies to coolies who cannot be employed on this kind of work on daily labour.

As regards the various species of grass. These come into the category of "good," "bad" and "indifferent." The "good" includes *Paunia*, *Mushan* and *Shahra*.

Paunia and *Mushan* are comparatively short and fine grasses and usually found on deep or damp soils. *Poolas* of *Paunia* can be recognized by the small lumps of adherent black cotton soil which come up with the roots from the damp ground: this has, of course, to be removed and it is difficult to convince coolies that mud is not wanted in Mesopotamia. *Mushan* bears more resemblance to English hay grasses than most. *Shahra* is a very tall grass, usually found growing on hill-sides in a peculiar tufted manner, as if the clumps had been planted out artificially at regular intervals. These grasses are commonest in the south and west of the Central Provinces and Berar.

Under "bad" the writer would classify spear grass cut after the spears have fallen and he would certainly not give it to his own horses. Curiously enough, the army grass people have a great predilection for this grass, though cultivators don't care to feed it to their cattle. Horses at the front are induced to eat it by sprinkling it with water in which rock salt has been dissolved. It is a first class thatch grass. Spear grass cut *before* the spears have completely formed is, however, quite fair fodder, though not as good as the grasses above mentioned. Unfortunately, the spears begin to form before the rains are quite over, and though private owners can arrange to hay it for their own use at this time it would be risky and impracticable to do this on a large scale. Once the spears form they are difficult to remove until they begin to twist together and "Mat." Care has, however, to be taken that spear grass is not carted or stacked while the spears are still in evidence. Owing to their hygroscopic tails, they become endowed with the power of motion as the dew forms at night and dries during the day, and to get spears out of grass which has been stacked for any length of time is only comparable with looking for the needle in the proverbial hay-stack. When the grass is in the "Mat" condition, however, the spears can easily be combed out. Spear grass is by far the commonest grass, and constitutes probably three-quarters of the grass found in the Central Provinces not including Berar.

Lemon grass also comes into the category of "bad" as animals object to the taste of the oil.

Most other grasses such as "*Gondel*" come under the head of "indifferent." *Gondel* is the coarse orange-coloured grass frequently seen growing near the railway line, and is one of the most widely distributed grasses to be found everywhere, especially on old fallows and field boundaries.

Before being steam-pressed, the grass has to be passed by a Military Officer who visits various pressing centres allotted to him. This officer is usually a very young Cavalry Lieutenant who, to start with, hasn't the foggiest notion of what is good or bad grass. Being the representative of the purchaser, he is not infrequently

harried in his endeavours to keep up a supply of unadulterated grass free from spears, etc., by excitable Forest Officers who tell him that unless he can pass their grass they must refuse to produce any more. However, a *modus vivendi* is usually established in a short time, and the young officer develops a remarkably keen eye for solitary spears and dirty grass. The latter is due to *poolas* cut in areas under fire-protection, which contain grass of the previous year in a condition of advanced decay. It is said rightly or wrongly to produce colic in horses, but cattle don't seem to mind it. Chewing the cud has possibly an antiseptic effect.

The luck of the BRITISH army has held with the hay season now closing. The cotton crop being barely a four-anna one, there have been plenty of carts available for carting hay, and owners of presses have been glad of the "*grist to the mill*." In an ordinary year, the demand for carts caused by the hay business would have been difficult to meet. The wages earned by the coolies and cartmen have brought money into parts of the country where, owing to adverse climatic conditions, the crops have been more than a partial failure. Where we have been extraordinarily lucky is, however, in our weather. To have had practically no rain between November and March is almost unprecedented.

Many of the workers supplying grass have raised anxious eyes when, for a series of evenings, the clouds have gathered only to disperse without giving trouble.

The writer shudders to think what might have happened had there been a week's heavy rain any time since Xmas at the various pressing centres where, owing to want of lashing material, railway wagons, etc., there has been a "hold up" with hundreds of tons of hay rolling into the press compounds and little coming out. Once the hay carts start to roll in, it doesn't do to stop them, otherwise a big industry gets disorganized at once.

Nor so far (touch wood) have we had any big fires in spite of the somewhat haphazard methods of work.

On the whole, the Forest, Civil and Military officials have worked as one team, though occasionally some red tape wallah has butted in with the letter of the law in his mind evidently above the spirit

of the undertaking, which it need hardly be added is "Don't waste time but help WIN the WAR as soon as possible."

The experience of the current year should not be lost and there are many points at which improvement can be effected. We all hope that the WAR will be over before next year, but the probabilities seem to point to a considerable demand for hay in 1919. The writer is not aware whether it is possible to divide hay into two classes according to quality for use at the front, but a business firm would probably not only do so but also be prepared to pay a higher rate for the better quality. To take an instance, should the WAR stop suddenly and there be numbers of bales of hay for sale in Bombay, those bales containing *Shahra* would fetch a good price, whereas those containing the old spear grass would probably be unsaleable. It would probably be worth our while to cart *Shahra* or *Paunia* longer distances at greater expense, so as to increase the proportion of this grass at the expense of the spear grass. Curiously enough, spear grass and "*Gondel*" are costing Government more than the better quality grasses, owing to the fact that the distance by rail from the forests containing the latter to the cotton-presses is less. In fact, the bulk of the *Shahra* and *Paunia* grass is carted direct to the cotton-presses and has to be either hand-baled or railed. The cost of railway is not, however, paid by the Forest Department and so does not come into their calculations.

In future, provision should be made to provide sheds at or near the pressing centres for storing loose grass in the event of a "hold up." Usually a press can keep pace with a very large team of carts and can, if necessary, work both night and day, but even then there must always be at least four days' supply handy for the Military Officer to pass. The present system of allowing hundreds of tons of hay to be exposed to the weather for months is asking for trouble.

If possible, one Military passing officer should be attached to each district so as to avoid dangerous accumulations in his absence. At the same time more use might be made of the passing officer. He could easily be placed in charge of the press work and work directly under the Minister of Munitions. The pressing and

despatching work devolves quite unnecessarily on the overworked Deputy Commissioner, and when he is out in camp a good deal of valuable time may be lost by orders having to be communicated through him. The passing officer would have plenty to do taking delivery, keeping tally of the bales and arranging for their despatch by train. In most districts there are three or more pressing centres, so he would have his work cut out. A comparatively small addition to the number of passing officer now employed would meet the situation.

F. T.

NOTES FOR THE USE OF DYE-WOODS.

BY T. SINGTON, OF MARSDEN CHAMBERS, MARSDEN STREET, MANCHESTER.

The scarcity of dyes during the last two years has drawn attention to the properties of dye-woods, some notes on the strength and purity of some dyes yielded by them may be useful for reference, and may encourage the production of dye-woods in India and a search for possible supplies not now known. One of the most important sources of vegetable dyes is logwood. The dyer must either buy his logwood in the log form as imported, and both cut and mature it himself, or he must purchase it chipped, rasped, or as an extract, which may be in the form of powder, or paste. Chipped wood is, as the word implies, in small chips or flakes and is usually somewhat cheaper than rasped wood, as it requires less labour, but the colour is more difficult to extract and the maturing cannot be so thorough. It can only be used for goods in which the chips cannot get entangled, so that for many purposes it is not available. Rasped wood is like coarse saw-dust and is the form commonly used by manufacturers of woven goods. It is important to note, that this rasped wood should be quite free from "gripps," which are dark needle-shaped splinters; they should be shifted out by the grinder before the wood is matured. An approximate opinion of the condition of rasped wood may be obtained by experts, from the way it rubs up in the hands, which should be quite dry and clean during the experiment. The colour should be

rich crimson red, neither tending to yellow nor brown. Should the experiment yield a yellowish shade, it is obvious that the dye has not been sufficiently matured and the wood may be described as young, but if the resulting colour is a brown, it suggests that the fermentation has been carried too far, so that a considerable percentage of the colouring matter has been lost.

The colouring principle of logwood is a yellowish-white crystalline body known as haematoxylin, which is readily soluble in hot water, but which has to be oxidized before the colour is developed. After being cut from the log, the rasped or chipped wood is generally laid in heaps, or beds about 18 inches deep, which require to be well and repeatedly watered and turned over as well from time to time. This treatment results in fermentation being set up in the course of a few days, accompanied by a considerable increase of temperature, which must not be allowed to exceed a certain limit, lest the colouring matter should be changed to a brown resinous body, with a very considerable waste of strength. A high temperature hastens the fermentation and may necessitate a more frequent turning over of the heaps or beds, at least once daily, so as to maintain the heat within limits. Cold weather has, of course, the opposite effect, the maturing is retarded and twice the time is required during the winter. A frequent watering with very weak solutions of alkalies, glue water or urine, assists the maturing of logwood, but the system involves considerable risk, as it may cause a too rapid fermentation. Alkalies oxidize the haematoxylin into the red colouring matter haematin very rapidly and not only impart a rich crimson colour to the wood, but cause it to bleed freely and appear to be rich in dye. The brousy appearance seen on dried logwood is due to the ammonia salt of the colouring matter, not to the colour itself. Logwood, which has been treated with alkalies, is much more likely to deteriorate with keeping, than that matured in a natural way, as the alkaline combination is acted upon quicker by the air, forming a useless brown resinous matter at the expense of the dye. Urine is a favourite agent for watering, as it is much safer to use than soda-ash, or other chemicals and is much more difficult to detect.

GERMINATION OF *CUPRESSUS TORULOSA* SEED.

BY MATHURA PRASAD BHOLA, P.F.S.

The considerable failure of direct sowings of *Cupressus torulosa* in the past, led me to carry out small sowing experiments in flower pots in my bungalow at Pauri (elevation about 6,000 feet) in the monsoon rains of 1917. The seed was sown in the pots early in the month of July, after being subjected to the following four separate processes :—

- (a) Soaking the seed for 24 hours in water before sowing.
- (b) Mixing the seed with cow-dung 24 hours before sowing.
- (c) Sowing without subjecting the seed to any process.
- (d) Keeping the seed for three minutes in boiling hot water before sowing.

The results obtained are shown below :—

Process of preparing the seed before sowing.	No. of days the seed took in germinating.	Percentage of success in germination.	REMARKS.
(a)	12	69	The pots were kept in the open, exposed fully to the effects of rain and sun.
(b)	10	66	
(c)	12	70	
(d)	15	2	

The results of experimenting with processes (a), (b) and (c) are practically the same, though process (b), that is, sowing the seed 24 hours after mixing it with cow-dung, accelerates germination. Process (d) was a failure, owing apparently to the adverse effect of boiling hot water on the vitality of the seed.

Seeds were sown at the same time in nursery beds in lines, and in the forest near Pauri in patches made in well-prepared soil. The germination took place two to three weeks after sowing, whereas the seed sown in August 1916 germinated only in the following October.

The earlier germination in 1917 was due to the constant soaking the seed received from the heavy and continuous monsoon rains

of that year, which conditions did not hold in 1916. The seed sown in the forest in the winter of 1915-16 resulted in almost complete failure on account of scanty rains.

The conclusions arrived at from the above observations are that, in order to attain success, both in direct sowing and in nursery beds the seed of this cypress should be sown soon after the break of the monsoon rains, so that it may have the whole of the wet weather before it in which to germinate. If this is done, there is no real necessity of preparing the seed by mixing it with cow-dung before sowing. Winter sowings generally result in failure and are not recommended.

CORRESPONDENCE.

TO THE HONORARY EDITOR, *Indian Forester*.

A FOREST JOURNAL.

I.

SIR,—In his letter on the subject of Forest Journals (*Indian Forester*, XLIII, 1917, pp. 512—515), Mr. Shebbeare comments on the difficulty of classifying material under various sub-heads.

I venture to draw attention to the methods that might be adopted for the record of information under one head, *viz.*, Insect Pests, and to emphasize the necessity for caution in the interpretation of data collected.

Of the Forest Journals I have had the privilege of seeing, I do not recall one that furnished useful, and at the same time reliable, information with regard to an insect pest; the records were either too vague or were specifically incorrect.

The following examples may illustrate the latter point:—

- (1) Records have been kept in a teak plantation in Madras since 1903 of annual defoliation, assumed to be entirely due to two species, *Hyblæa puera* and *Pyrausta machæralis*. Investigation has since shown that (a) the teak in that region is mainly defoliated by species of Arctüdæ and Noctuidæ, and (b) *H. puera* and *P. machæralis* are of sporadic occurrence.

- (2) A Forest Journal in North Burma recorded the attacks of the bee-hole borer in 2—5-year old teak plantations, with the remedial measures carried out and their beneficial effects. Investigation showed that (a) the saplings were attacked by the ghost moth borer and the longicorn borer, while the bee-hole borer did not occur in the locality, and (b) the remedial measures were carried out six months after they could possibly have effect either way.

Several of our better known forest insects have built up a wholly spurious reputation as pests, on the fabric of an original incorrect record in a Forest Journal, which has been repeated in annual reports, in bulletins, and thence in standard works of reference and entomological journals.

There is a tendency for Forest Officers, under the influence of their European training, to assume that the important pests of a tree are numerically few, and that these species occur with unvarying importance throughout the range of the host-tree; whereas in India we have to deal not with single species, but with groups or associations of species, that vary relatively in abundance from year to year, and division to division.

In my opinion, it is useless, at present, to attempt the record of information on insect pests, species by species, unless authoritative identifications are obtained, at least in the first instance. The Research Institute exists for the purpose of consultation, but little advantage is taken of this fact.

At the last meeting of the Board of Forestry in 1916, it was suggested that insect pest damage should be recorded under heads representing the class of injury, and not by species, until the pests of a division had been definitely established by expert identification. The scheme of classification is given as Annexure I to my note on the systematic record of insect damage. (Proceedings of the Board of Forestry, March 1916, pp. 67—73.)

When we have devised for the recognition of insect work practical rule-of-thumb methods, which even subordinate officials can use, we shall be in a position to record the annual or

periodic importance of certain selected pests of the more important timber species.

31st January 1918. C. F. C. BEESON, I.F.S.,
Forest Zoologist.

A FOREST JOURNAL.

II.

SIR,—In your November and December issue, Mr. Shebbeare voices what I believe is a very common opinion when he writes that Forest Journals are generally useless as the information they give is obtainable from the Annual Reports or elsewhere, and is not classified according to any useful system. The crucial point which is generally overlooked is, I think, that a Forest Journal should contain no information relating generally to the forests as a whole or to a large part of them—such information should be available in the Annual Report,—what is required is particulars regarding occurrences which affect the management in the smallest working unit whether a forest, compartment or sub-compartment. This, I think, also answers his question regarding classification; it should be by working units and then by years. Only by keeping up journals in this manner will they serve their most useful purpose, which I take it is insuring a continuity of policy in spite of changes in the supervising officers.

As regards the question of what information should be entered, this must be decided according to the local circumstances, observing the principle that only such things should be entered as affect the future working of the unit. In Burma, apparently, information relating to roads is entered; in the Punjab, where the units are smaller, roads generally serve several units, and if further information is required than is given in the control forms it is better entered in a road register. If there is a working-plan then the form of Forest Journal to be maintained should, I think, be prescribed by the Working Plans Officer; indeed, in my opinion, the Forest Journal is the most important of the working-plan control forms. Some four years ago, I made a working-plan for the

Rawalpindi Chil forests which were to be worked on a system of successive regeneration fellings. The question of regeneration was a very difficult one, and the divisional charge being a very heavy one there was great danger of lack of continuity of policy in the operations in the individual working units and of the results of these operations being not sufficiently carefully watched. I prescribed a Forest Journal as one of the control forms and laid down that under each compartment should be entered :—

- (a) When fellings were made, notes by the marking officer as to how he had marked them and where.
- (b) When the next regeneration felling would probably be required and how it should be made.
- (c) Subsequent notes on the results of the fellings.
- (d) Cultural works and their results.

I am writing from recollection only but the above were, I think, the most important points. Mr. Shebbeare states that some people think that a Forest Journal should be a book for Conservators and D. F. O.'s inspection notes. This may be sufficient where the forests are not under intensive working but, for scientifically worked forests, I think a journal of this kind is quite insufficient.

M. R. K. JERRAM, I.F.S.

A PLEA FOR THE MORE RATIONAL USE OF JUNIOR FOREST OFFICERS.

SIR,—The article entitled “A Plea for the more Rational use of Junior Forest Officers” by “NGADAUK” in your September number was doubtless read with great interest by officers in Burma. As one of the “20 Imperial Officers of eight years’ service and under” I welcome his suggestions and wish that the writer had added more weight to his contentions by revealing his identity. Up to about three or four years ago, Imperial Officers of three years’ service or thereabouts were given an independent charge, and although that arrangement may or may not have been ideal it did give men a chance of showing their initiative and spurred them to do good work. About that time, however, a few officers failed to pass their

examination in Burmese within the prescribed period, and immediately arose an outcry as to the inferiority of Oxford trained men as compared with Coopers Hill. As a result all were tarred with the same brush and it became more or less generally accepted that all were too lazy or indifferent to pass their examination and were therefore useless. Whether it be coincidence or not A. C. Forests have since then been employed on practically nothing except girdling in the open season; and to anyone who has done this monotonous and mechanical work for six or seven months on end it is no wonder that men become apathetic. There is another matter which requires setting right and that is the training of junior officers. Some D. F. O.'s I say some advisedly because there are some shining examples to whom it does not apply, do not seem to remember that Assistants are attached to their divisions for training as future D. F. O.'s and not as automatic girdling, thinning and timber measuring machines. The consequence is that junior men go on until they are shot into a division having only the vaguest idea of Office and Accounts procedure. In the end it works out all right, but it is not business. The solution seems to be to give junior attached officers charge of important works (as in the case of Timber Assistants) and let them run them more or less independently under the advice of the D. F. O. In the rains they should, as far as possible, be put in charge of the Divisional Office. Whenever a division is available temporarily, through the permanent incumbent taking a month or two months' leave, a junior man should be given temporary charge. Yet how often do we see senior officers given charge of two divisions under these circumstances, even when there are comparatively senior Assistants in the same station. It is difficult to see how the charge allowance to the senior man can be justified to Government in these cases. With regard to giving junior men permanent charge of divisions, of course that is impossible at present as there are not enough to go round, but when leave is opened again, it is to be hoped that the idea suggested of having to have nine years' service to qualify for a division will be dropped. Men now come in at about the age of 24 and if they are not fit at the

age of 30 to take the responsibility of independent charge then they never will be. Also it is a mistake to suppose that the supply of good fish in the sea is exhausted.

The last para of "NGADAUK'S" letter refers to an important matter about which the rank and file of us have heard nothing. After the War is over, there will most likely be a boom in the timber trade and probably an opening for our timbers, including the so-called jungle woods, in Europe. If the War is over next year shall we be prepared with working-plans and schemes to meet any demand that can possibly arise? If we are found talking and writing theory on the subject and with no oil in our lamps, it will be an everlasting blot on the fair fame of our Department.

THARRAWADDY :

R. UNWIN.

12th October 1917.

EXTRACTS.

INDUSTRIAL COMMISSION AT MANDALAY IN BURMA.

The following is an extract from the statement made to the Industrial Commission at Mandalay on the 31st January 1918 by Mr. A. E. English, C.I.E., I.C.S., whose opinion, matured by very long and intimate connection with Burma, is of the utmost value :—

"As I have said above, the main industry of this province subsidiary to agriculture should be the lasting one of the exploitation of its forests. The forests are extensive and contain an enormous variety of trees, many of which are valuable. They also contain much other produce of commercial use. If properly conserved they not only persist but improve, and in this respect are unlike mines and oil-fields. They are well placed all about the country and, in my opinion, one of the very first things to do in promoting industries is for Government to provide an adequate forest staff

to develop these forests to the best advantage. It is of course necessary to develop other useful industries such as leather working, pottery, weaving, etc.; but it is certain that the forests can provide remunerative occupation for all classes of the community from cooly to capitalist for years to come, provided they are properly conserved and worked. The policy of the past appears to have been in forest matters to get the maximum revenue with minimum establishment, regardless of waste. It is the long view that must be taken and the proper policy should be to put on the full staff now with a view to continuous and progressive development until the maximum extraction and revenue are arrived at in perhaps fifty years. We require silviculturists, research officers, working-plans officers, commercial officers, revenue collectors and forest engineers. We want capital for forest roads, for forest railways, for forest machinery, for silviculture and for improvements."

WORST LOG JAM IN HISTORY.

A misfortune altogether without precedent has befallen those branches of the wood goods industries which obtain their raw material and logs from the Glommen River district. The Director of the Association, under whose management lies the floating of the logs in the River Glommen, has sent the newspapers for publication, a letter which he has addressed to the Association of forest owners.

An immense quantity of logs should be floated down the river; a late spring and a rapid thaw have caused a quantity, estimated at about 450,000 dozens of logs to be piled up at Bingfoss lock, tied one with the other almost inextricably in an enormous height, and it is only possible to extricate the logs one by one with immense work and difficulty. Instead of employing usually about 20 to 30 men, the Association has now 130 men engaged who work night and day to try to loosen this mighty mass of timber. Although everything has been done to stop more timber from coming down to Bingen, the river still carries a great

deal of timber, and the quantity at Bingfoss is thus steadily increasing.

"As the situation now is," says the Director, "it is hardly probable that we shall be able to clear the timber at the Bingen lock in a shorter time than two years and there is no prospect of being able to release this year much more than one-half of the quantity of timber which has been marked this season for being floated in the Glommen River."

This very serious situation will prevent not only the mills but also the many parishes who have bought timber in lieu of coal, from receiving the timber which has been cut and marked for their account for being floated in the Glommen River. And, still more, it will not be advisable for the mills to contract for logs, in the autumn, for cutting and for floating next spring. It is, therefore, more than probable that the saw, cellulose, and mechanical wood-pulp mills which receive their timber by floating in the Glommen will be compelled to stand idle for one year, as soon as they have used up their present stocks of timber.

This is an event which is without any parallel in the very long time which has elapsed since floating of logs in the Glommen River commenced, and it will affect the planing mills at Fredrikstad, among other cellulose mills the large mills belonging to the Kellner-Partington Paper Pulp Co., the Greaker cellulose mill, and all the other mills which are situated by the Glommen River, but more or less all pulp mills in the south of Norway will be inconvenienced by this stoppage, for all of them obtain at least a part of their log supply from the Glommen River district.—

[*Farmand.*]

Extract from the "Near East," dated 10th August 1917.

CYPRUS NOTES.

THE PROBLEM OF GOATS.

Rustem Pasha, when Governor of the Lebanon, used to say that what gave him most trouble was the goats and the priests. In Cyprus the question of goats has always been a source of worry and anxiety; but, unfortunately, it has never been handled with the firmness that the circumstances required. Just as the preservation of what remained of the forests became one of the principal subjects of consideration for the British Administration, so the depredations of goats called for serious attention and repressive measures. The British Government at once took in hand the protection of the forests, though with quite inadequate means at its disposal. On the other hand, the evil caused by goats both to forests and agriculture was left to a great extent unchecked. It is precisely as if a patient were treated methodically for a serious complaint, while allowed at the same time to indulge in a poisonous luxury which undermined the whole system.

INJURY TO FORESTS AND AGRICULTURE.

The earliest and best report on the Cyprus forests by M. Madon, an officer lent by the French Government, stated clearly the lines upon which forest policy should be based. All authorities have insisted on the fact that forest growth and the grazing of goats are incompatible. Anyone, indeed, who has studied treatises on the subject is perfectly well aware of this truth. Flocks of goats, however, have been allowed to exist and multiply in Cyprus, with the result that the island has suffered year by year injury which the principal Forest Officer has endeavoured roughly to estimate in recent reports. It would have been far better in the long run, had the Government taken a firm line from the outset, and, putting up with perhaps a little outcry from a particular class had served the general interests of agriculture by the reduction or destruction of this inveterate foe to husbandry. No doubt there

would have been some bitter feeling and grumbling, even outside the flock-owning class; but that has been the case wherever action has been taken against goats.

As regards the State forests, the delimitation of which was undertaken in the early years, goats were excluded (though in a few localities rights to graze, possessed at antiquo, were respected); but, of course, much depredation must inevitably take place over large areas which cannot be adequately patrolled by the small staff of forest guards. As to private properties the difficulty has been great, but in reality it only required firm handling. It has been left to the Legislative Council to discuss what remedies should be adopted, and the results up to date have certainly not been satisfactory. A law passed a few years ago allowed the inhabitants of any village to decide by majority whether goats should be tolerated in their lands or not. A fair number of villagers have taken advantage of the measure, but ambiguities as to its application have rendered amendments necessary.

EITHER GOATS OR AGRICULTURE.

Fortunately it would seem that the good sense of the native communities is at last tending more and more in favour of eliminating this island plague. At any rate, it is very satisfactory to know that there are now members in the Legislative Council who have the courage to defend a strict forest policy and war upon goats. No one has insisted on this more vigorously than Mr. Theodotou, one of the members for the Nicosia-Kyrenia division. A short time ago he warned his countrymen that it was a choice between goats and agriculture, and told them plainly that goats were just as great a pest as locusts. He aptly referred to the case of Algeria, where, owing to measures such as are required in Cyprus, the area of forest land has been quadrupled in about forty years. "Whenever I go on district tours," he said, "and advocate tree-planting, I hear the same reply: 'Let us plant trees, in order that shepherds may destroy them.' No wonder our agriculture does not advance." Those who kept goats, he continued, were in reality condemning the country to economic disaster, and he

expressed himself in favour of the gradual abolition of goats "in order that the resources and productiveness of our fields and forests may prosper and be further developed." Breeds of sheep and cattle, he rightly argued, should be raised in their stead. Mr. Theodotou stated, as an example of the mischief caused, that in one village 3,000 trees were planted a few years ago, and of these all but thirty were destroyed by goats or shepherds. If a villager prosecuted a shepherd, and a fine was inflicted, next day he might find his animals mutilated, his trees cut down, his crops destroyed, or even his life in danger. This is one aspect of rural life in Cyprus. Very large sums have been spent in the destruction of locusts, and it might have been wise and expedient to devote a sum annually to the compensation of flock-owners while compulsorily reducing this other pest of the agriculturist.

DOMESTIC OCCURRENCES.

BIRTH.

BELL—At Jubbulpore, C. P., on the 8th March 1918, the wife of C. F. Bell, Indian Forest Service, of a daughter.

INDIAN FORESTER

MAY, 1918.

RECENT INVESTIGATIONS ON SOIL-AERATION.*

PART I.—WITH SPECIAL REFERENCE TO AGRICULTURE.

BY ALBERT HOWARD, C.I.E.; M.A., A.R.C.S., F.L.S.,
IMPERIAL ECONOMIC BOTANIST.

PART II.—WITH SPECIAL REFERENCE TO FORESTRY.

BY R. S. HOLE, F.C.H., F.L.S., F.E.S., BOTANIST, FOREST RESEARCH
INSTITUTE, DEHRA DUN.

PART I.

I. INTRODUCTION.

The growing of a crop is an exercise in applied physiology. This operation, as is well known, is only possible through the simultaneous operation of a number of soil factors—water, mineral salts, temperature and oxygen. What is not always fully realized is that if any one of the factors concerned, for example the supply

* A lecture delivered to the Indian Science Congress at Lahore on January 9th, 1918.

of combined nitrogen, is in defect, growth is checked and stops altogether when this substance is no longer available. Nitrogen is then said to be a limiting factor in growth. On the addition of a further supply of this substance, growth at once recommences and proceeds till the crop is ripe unless some other factor becomes deficient. A crop, limited in growth by a deficiency in the supply of any particular factor, is not influenced by the increase of other factors. Thus a shortage of combined nitrogen is not made up for by the application of phosphates or potash or by increased irrigation. Just as the strength of a chain is limited by that of its weakest link, so the growth of a crop depends on the factor in greatest defect.* The chief object in soil-management is the removal, in advance, of any possible limiting factor which may operate adversely.

The aeration of the soil is a factor in growth which has been greatly neglected in the past. The three substances involved—oxygen, nitrogen and carbon dioxide—are gases which are invisible and are not on the market in the form of artificial manures like nitrate of soda or superphosphate of lime. Only very indirectly has soil-aeration been recognized in the European literature on agriculture in the importance attached to a proper soil texture. Soil texture is really important because of its influence on soil-aeration. In this lecture it is proposed to refer to some of the recent work on soil-aeration and to indicate the direction in which further investigation is needed particularly in the irrigated tracts of India.

II. AERATION AND THE AMOUNT OF GROWTH.

If growth is influenced by the aeration of the soil, the effect of this factor should be apparent in any series of cultures where all the conditions are uniform except the ventilation of the roots. A number of investigations have recently been carried out on this point from which the following examples are taken:—

1. *The effect of increased aeration on the root development of barley.*—This matter is dealt with in one of Mr. Hall's papers in

* In the case of the temperature factor, growth is also limited when the optimum is exceeded.

the *Philosophical Transactions* (B, vol. 204, 1913). One example taken from this paper will suffice.



Fig. 1.—Growth of barley in solutions aerated once a day (left) and aerated continuously (right).

On the screen are represented two water cultures of barley (Fig. 1). The bottle on the left was aerated once a day, that on the right was aerated continuously. It is clear that both root development and growth depend on the amount of aeration.

2. *The effect of soil texture on growth.*—The results published by Mr. Hunter in vol. IV of the *Proceedings of the Philosophical Society of the University of Durham* show the marked effect of soil texture on growth. Various kinds of soil were used and the plants selected were sunflower, peas, wheat and cress. Five degrees of soil texture were adopted as follows :—

1. Soil in small lumps, loose.
2. Soil fine, loose.

3. Soil fine, firm below, with a loose surface.
4. " " firm.
5. " " hard.

The results obtained are shown on the two following slides (Figs. 2 and 3).

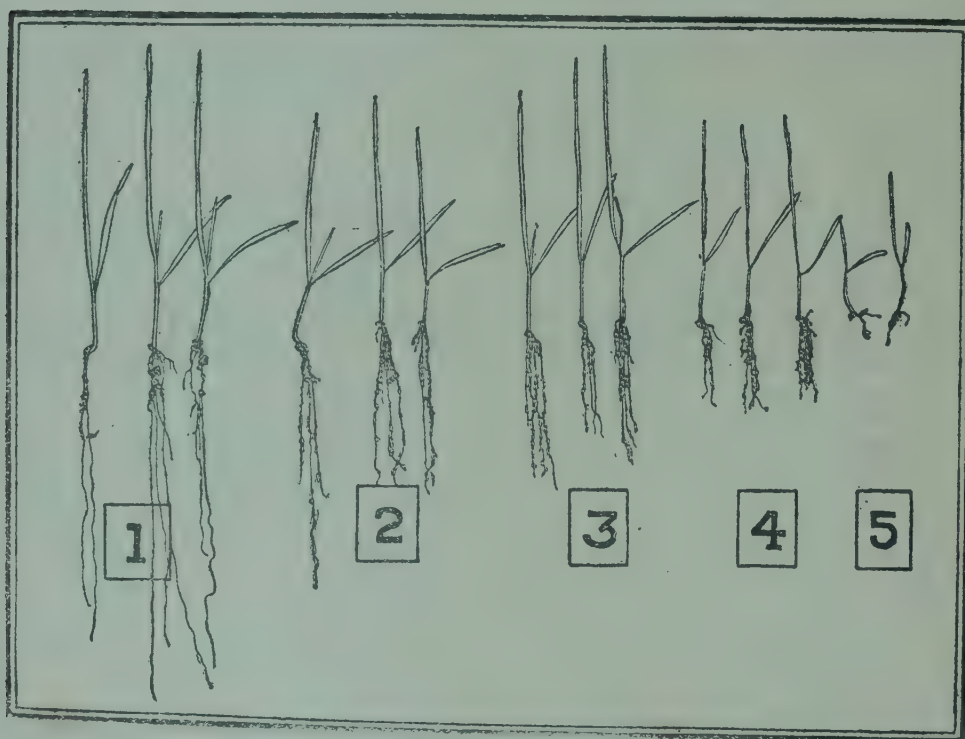
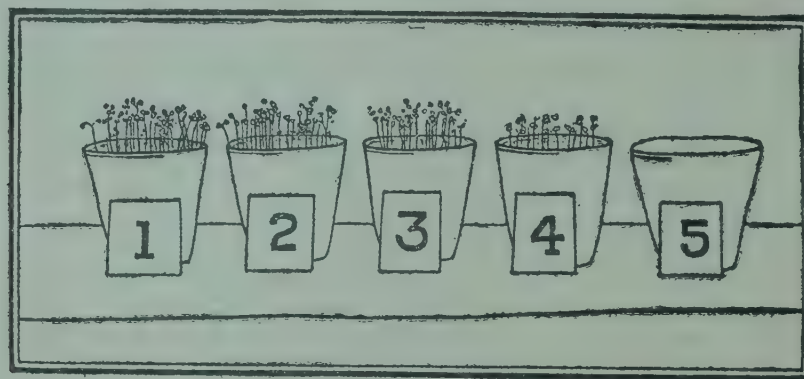


Fig. 2.—The effect of soil texture on the growth of cress and wheat.

The first (Fig. 2) shows the effect of soil texture on the growth of cress and wheat. Where the soil was hard, the cress seeds did not germinate. In the case of wheat, the effect of the texture on root development is very clear. The closer the packing, the poorer

the growth. The corresponding results with peas are shown on the next slide (Fig. 3).

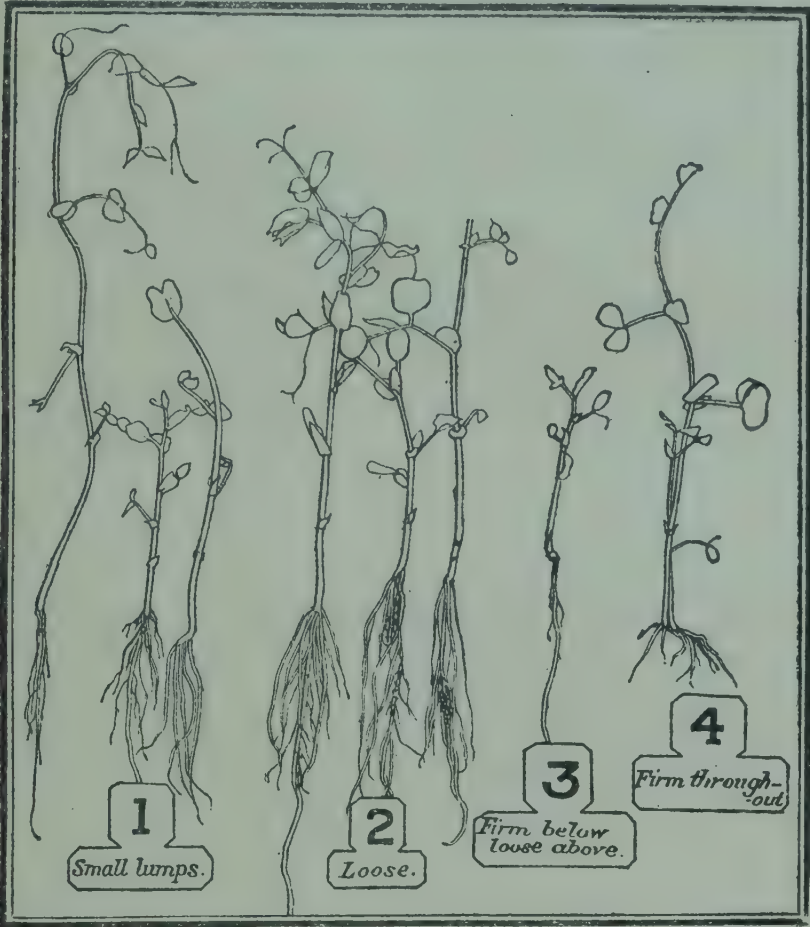


Fig. 3.—The effort of soil texture on the growth of peas.

Here the best growth was obtained where the soil was fine and loosely packed. Mr. Hunter next measured the effect of soil texture on the resistance to an artificial air current. It was found that the resistance of columns of soil were in accordance with their textures. The results are to be seen in the table on the screen.

TABLE I.—*Soil texture and air movement.*

Description of soil.	Height in cm.	Resistance offered.
1. Small lumps, loose	35	1 unit.
2. Fine, loose	35	2 units.
3. Fine, firm below with loose surface	5 } loose	17 "
	30 } firm	
4. Fine, firm throughout	35	42 "
5. Fine, hard throughout	35	310 "

3. *The effect of adding potsherds or sand to the Pusa soil*.*—

The soil at Pusa is a calcareous silt which readily forms a surface crust and often loses its texture altogether after long continued heavy rain. The addition of one inch of potsherds to the heavy soils of the botanical area increases the yield considerably. Some of the results obtained are given in Table 2.

TABLE 2.—*The effect of diluting the Pusa soil with potsherds or sand.*

1. Wheat, oats and tobacco.

Crop.				Yield per acre of control plot.	Yield per acre with one inch of potsherds.	Increase per acre.	Percentage increase.
				m. s.	m. s.	m. s.	
Oats	...	...	...	24 17	28 36	4 19	18
Wheat	...	...	...	16 18	19 30	3 12	20
Tobacco	...	...	...	21 0	23 3	2 3	10

2. Indigo.

Kind of soil.				No. of plants measured.	Average length in cms.	Percentage increase.
Soil only	...	...	...	33	36·7	0
50 % soil + 50 % sand	...	...	...	36	51·6	40
90 % soil + 10 % potsherds	...	...	...	33	48·3	31
70 % soil + 30 % potsherds	...	...	...	35	50·9	38

These examples, selected from many others, are sufficient to illustrate the main fact that soil-aeration is one of the factors on which the growth of plants depends.

The structure of the soil.

To follow the subject further, it is necessary to consider the structure of the soil and the relation of this structure to the root

* Howard, A., *Bulletin 61, Agr. Research Institute, Pusa, 1916.*

system of the plant. The soil consists of particles with intervening spaces between them known collectively as the pore space. For every soil, the proportion of the volume of this pore space to the total volume of the soil varies with the closeness of packing. When the soil texture is good, the pore space is large. After heavy rains and when water-logged, fine silt-like soils run together into a condition of close packing when the pore space is considerably reduced. Thus the volume of the pore space varies according to circumstances. The pore space is taken up by two things—water and air. The water occurs in thin films round the soil particles, while the soil air fills up the rest of the pore space. The next slide (Fig. 4) represents the structure of the soil, in relation to the root hairs of a crop.



Fig. 4.—The soil in relation to the root hairs of a plant. The solid soil particles are darkly shaded, the air spaces are white, the adherent water is indicated by concentric lines. From the piliferous layer of the root two root hairs arise. (After Sachs.)

In the water films round the particles there is intense biological activity. New root hairs are constantly being produced by the plant which, for a time, absorb water and dissolved materials and then die. Various soil bacteria are occupied in the decomposition of organic matter. Both these activities involve

the process of respiration. The working protoplasm in each case uses up oxygen and carbon dioxide is produced as a by-product. The soil atmosphere is, therefore, constantly being called upon to supply oxygen for respiration and receives fresh supplies of carbon dioxide. Efficient ventilation is clearly essential if the air in the pore spaces is to be kept fresh. Supplies of oxygen must pass into the soil from the atmosphere and at the same time the excess carbon dioxide in the pore spaces must diffuse out in the reverse direction. The pore spaces are the living rooms of a vast underground city, the inhabitants of which require fresh air.

It is only very recently that investigators have begun the systematic study of the soil atmosphere in relation to the biological activities proceeding in the soil. Important and interesting results are being obtained at Dehra Dun by Messrs. Hole and

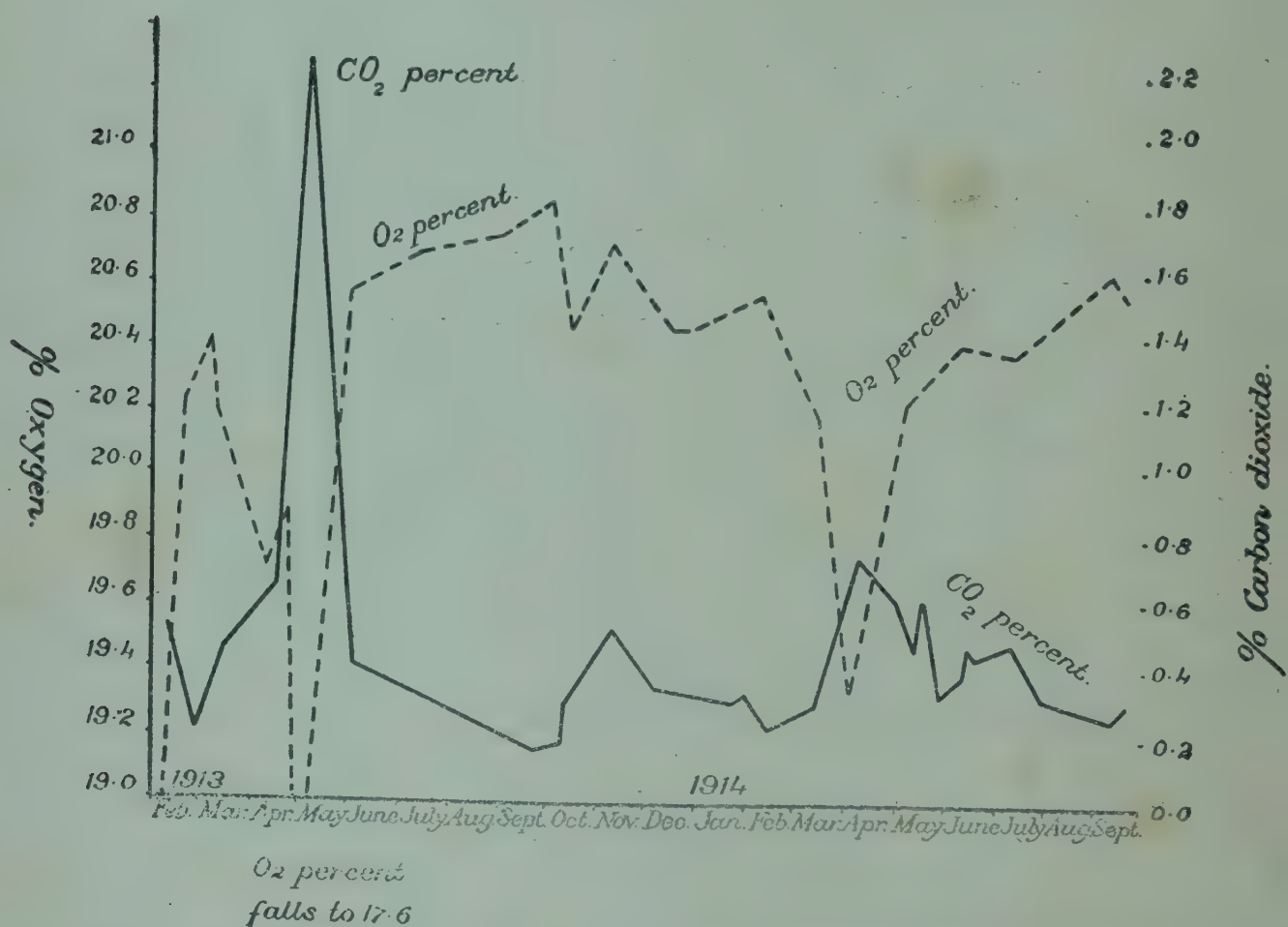


Fig. 5.—Curves showing percentages of CO₂ and of O₂ in soil air in Broadbalk dunged plot.

Puran Singh and at Rothamstead by Dr. Russell and his colleagues, some of which have been published. In general, Dr. Russell and Mr. Appleyard* find that the oxygen and carbon dioxide curves are reciprocal—the oxygen falls as the carbon dioxide rises. The agreement is sufficiently close to justify the assumption that the oxygen is mainly used up in producing carbon dioxide. One of these curves is shown in the next slide (Fig. 5).

These investigations also throw considerable light on the composition of the gases dissolved in the water films. These contain very little oxygen but a great deal of carbon dioxide as will be evident from the figures in the next slide (Table 3).

TABLE 3.—*Composition of gas held absorbed by soil. Percentage by volume.*

	Weight of soil used, grms.	Percentage of moisture.	Approximate vol. of gas removed in successive extractions.	Percentage composition of gas.		
				CO ₂	O ₂	N ₂
Pasture soil ...	352	28	1st 30 c.c.	52.0	0.7	47.3
			2nd 30	84.8	0.2	15.0
			3rd 22	99.1	0.2	0.7
Soil covered with vegetation (Broadbalk wilderness).	400	22	1st 30 c.c.	19.3	5.5	75.2
			2nd 30	57.0	2.6	40.4
			3rd 15	98.7	0.2	1.1
Rich garden soil ...	468	20	1st 30 c.c.	89.5	0.2	10.3
			2nd 30	99.3	0.0	0.7
			3rd 15	94.4	0.0	0.6
			4th 30	96.8	0.0	3.1
			5th 30	92.3	0.0	7.6
Arable soil (Broadbalk dunged plot).	...	24	1st 30 c.c.	10.8	4.4	84.8
			2nd 30	57.9	1.8	40.3
			3rd 15	98.4	0.0	1.6
Broadbalk unmanured	497	16	1st 30 c.c.	6.3	15.1	78.6
			2nd 25	40.2	9.7	50.1

The essential point is that the water films are exceedingly poor in oxygen but very rich in carbon dioxide. As they are

* Russell, E. J., and Appleyard, A., *Jour. of Agr. Sc.*, VII, p. 1, 1910.

the seat of an intense biological activity for which oxygen is essential, it is clear that the consumption of oxygen in the film is equal to the rate at which it is renewed. The details relating to the gaseous exchanges between the pore spaces and the water films need much more investigation and a further contribution has been promised by Dr. Russell. On physical grounds, we should expect that the water films would derive their supplies of fresh oxygen from the air in the pore spaces. The Rothamstead experiments, however, have disclosed another source, namely, the oxygen dissolved in the rain-water.* Rain was found in most cases to be a saturated solution of oxygen which stimulated markedly the biological activities in the soil. The effect of showers of rain was found to be greater than that produced by water alone and could be explained by the influence of the dissolved oxygen in replenishing the supply of this substance in the water films. That rain benefits crops has long been known and practical men have always felt that something more than a moisture effect is concerned. We know now that rainfall supplies both water and oxygen in the most effective form. In future, we must think of the Indian monsoon not as the distribution of so much rainfall over certain areas but rather of so much water rich in dissolved oxygen.

It will now be clear that one of the essentials for the growth of plants is the maintenance of the oxygen supply of the pore spaces and of the water films round the soil particles. The soil must be kept ventilated or the denizens of our underground city will languish for want of air. Let us study the ventilation of our underground city in connection with flood irrigation as practised by the cultivators all over Northern India. The soil is alluvial in nature. Its texture deteriorates if it is flooded with water. As it dries under the hot sun, the surface bakes into a crust largely impermeable to air. That the crust is impermeable can be seen by immersing in water a portion of the hardened surface soil after irrigation. The air escapes sideways not through the surface skin. Each successive irrigation destroys the soil texture still more and

* Richards, E. H., *Jour. of Agr. Sc.*, VIII, p. 331, 1917.

the surface crust becomes more and more impermeable to air. The effect of irrigation on alluvial soils, therefore, interferes with its ventilation. The process removes one limiting factor, the want of water, but it introduces another, namely, the need of aeration. That this is so will be clear from Table 4 which contains the result of a recent experiment at Quetta.

TABLE 4.—*The introduction of a new limiting factor after irrigation.*

Number of waterings.	Area in acres.	Total weight of produce.	Total weight of grain.	Yield of grain per acre.	Percentage reduction.
		lbs.	m. s.	m. s.	
One	3.99	10,367	52 6	13 2	0
Three	2.65	6,620	25 15	9 23	26

Here the last two irrigations reduced the yield through the introduction of another limiting factor—the need of soil-aeration. Clearly if we could work out a practicable compromise between the needs of the soil for water and for air under irrigated conditions, an immediate advance in agriculture would result. This has recently been accomplished at the Quetta Experiment Station. I propose to indicate briefly the manner in which it was done. The Quetta valley is typical of the upland valleys of Baluchistan. The soil resembles that of the plains of India and the characteristic of the climate is the dryness of the air and the amount of air movement. It is a dry, windy place. Irrigated crops, therefore, require an enormous quantity of water. Irrigated wheat is often watered six times and the crop shows all the symptoms of poor soil-aeration—excessive liability to rust attacks, slowness in ripening and shrivelled grain of poor quality. The irrigated wheat dries up rather than ripens and the bright straw and shining chaff which are so characteristic of this crop are not developed in the Quetta valley. It was obvious that enormous quantities of valuable irrigation water were being thrown away to

no purpose on the wheat crop. A method of growing the crop on a single irrigation was worked out which is now being taken up by the cultivators. The method consists in making full use of the preliminary irrigation before sowing and the breaking up of rain crusts afterwards. The details of the method are to be found in the bulletins* issued by the Quetta Experiment Station. Under the new method, the yields are often higher with one irrigation than with six or seven. Harvest is about a month earlier and the wheat ripens normally and develops the characteristic colour of the chaff and straw.

As the wheat crop on the Canal Colonies of the Punjab also exhibits definite signs of want of soil-aeration during the ripening period, I ventured to predict that at least one-third of the irrigation water now used on this crop is wasted. The matter was put to the test of experiment during the wheat season of 1916-17. The Punjab results are given in Table 5.†

TABLE 5.—*Results of water-saving experiments on wheat (Pusa 12) at Gungapur, Haripur and Sargodha in 1916-17.*

Station.	No. of irrigations including the preliminary watering.	Yield per acre.		Average yield per acre.	
		Grain	Bhusa.	Grain.	Bhusa.
		m. s.	m. s.	m. s.	m. s.
Gungapur ...	One ...	12 19½	20 10	9 34	21 17
Haripur ...	" ...	8 31	19 14		
Sargodha ...	" ...	8 12½	25 27½		
Gungapur ...	Two ...	18 0	25 8	16 11	25 5
Haripur ...	" ...	15 21	23 16		
Sargodha ...	" ...	15 12½	26 32½		
Gungapur ...	Three ...	14 25	18 0	15 11	22 2
Haripur ...	" ...	16 8	26 4		

An inspection of the figures shows very clearly that after the second irrigation water ceased to be a limiting factor and then began to depress the yield. Similar but still striking results were obtained by Mr. Main at Mirpurkhas in Sind. The significance of these results will be apparent when it is remembered

* Howard, A. and Howard, G. L. C., *Bulletins 4 and 7, Fruit Experiment Station, Quetta, 1915 and 1917.*

† Annual Report of the Imperial Economic Botanists, 1916-17.

that the annual revenue derived from irrigation works in India is about £5,000,000 sterling. Taking the Indian Empire as a whole, there can be no question that the water wasted every year would, if used to the best advantage, bring in a very large direct and indirect revenue to the State.

III.—SOIL-AERATION AND QUALITY.

The quality of vegetable products, as is well known, varies greatly with the locality. The quality of the wines of Champagne and of the tobacco grown on certain soils in Cuba depend to a great extent on the soil of these tracts. The transference of the vines of Champagne or of the tobacco plants of Cuba to other places does not mean the transfer of the special qualities associated with the wine and cigars produced in these localities.

What are the factors on which quality depends? The breed or variety is certainly one. A rough short stapled cotton for example can never be transformed by alteration in the environment so as to resemble the best Egyptian or Sea Island types. Such a cotton can be improved to a limited extent but the fibres will always remain coarse and short. It is suggested that besides the variety, quality also depends on another factor, namely, adequate soil-aeration. Many examples can be quoted in support of this view. It will be sufficient to mention the following :—

1. *Barley*.—The barley crop is grown all over England, the best samples being used for making malt. For the best beer, the barley grain must be well filled with starch so as to produce a rich clear malt-extract. Such barleys are always grown on light land where the natural aeration of the soil is good and where the crop ripens off quickly. On stiffer soils, the aeration is bad, the barley ripens slowly and the grains are often poorly filled with starch. Malsters do not like these barleys as they give a thin, cloudy extract.

2. *Tobacco*.—As is well known, the internal tobacco trade of India is enormous. Certain tracts such as the Parganah Saraisa in Tirhoot, Jais in the District of Rai Bareli and the Mustang valley in Baluchistan have achieved a reputation for quality which is well known in the trade. In all these places, the soils which produce the best qualities are those in which the aeration is much above the average.

3. *Cotton*.—Recent investigations in the Central Provinces indicate that soil-aeration is one of the factors on which the staple of cotton depends. Mr. Clouston has shown that on the open laterite plains near Raipur where the soil is such that its texture cannot be destroyed by heavy rain or surface flooding, long staple cotton of high quality can be produced. Further, the fibre of coarse cotton like Roseum is improved when this type is grown on these laterite soils. Similar results are obtained with other crops like ground-nuts and sugarcane.

No scientific explanation of the part played by soil-aeration in the development of quality has yet been put forward. The recent Rothamstead results, however, appear to throw light on this point.* If we compare the carbon dioxide in the soil atmosphere from cropped and uncropped land, two marked differences disclose themselves. The curves are to be seen on the last slide (Fig. 6).

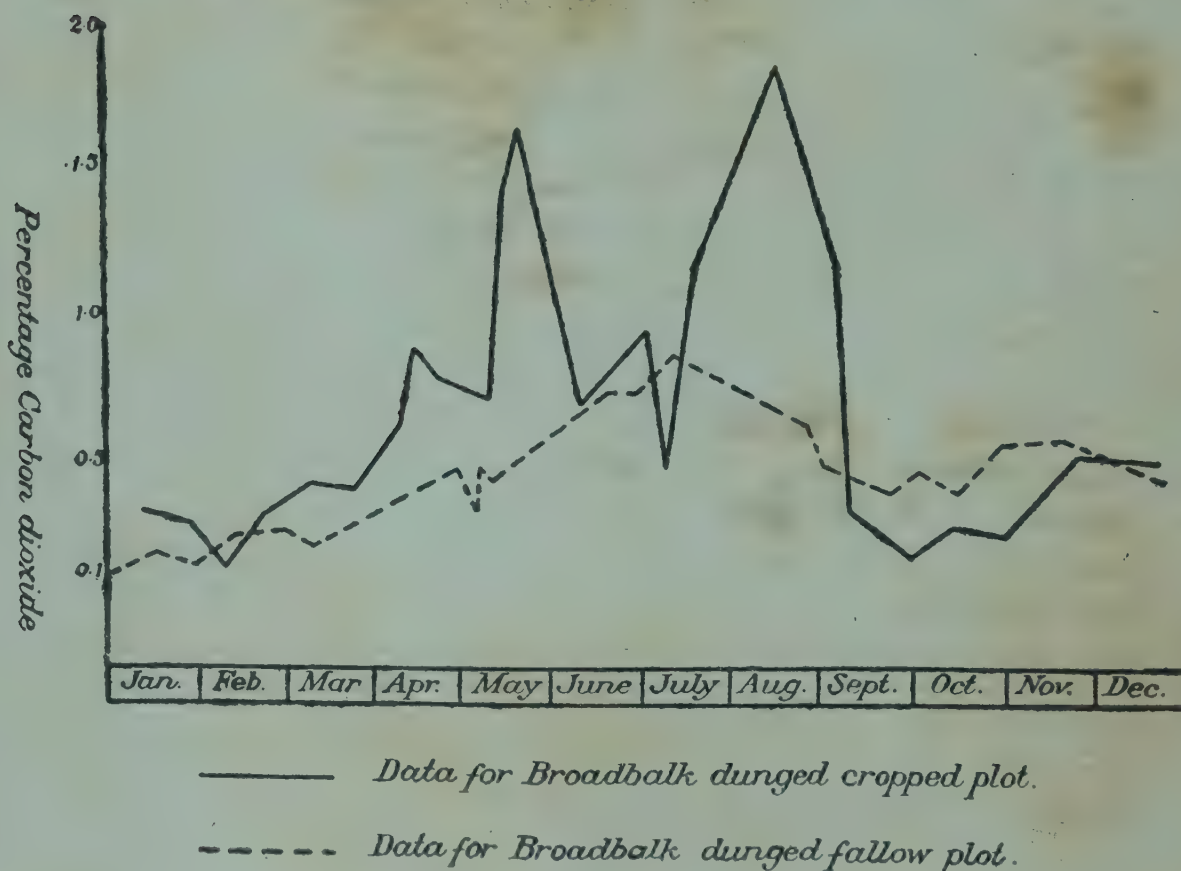


Fig. 6.—Percentage of carbon dioxide in the soil air of dunged fallow and of dunged cropped land.

* Russell, E. J., and Appleyard, A., *Jour. of Agr. Sc.*, VIII, p. 385, 1917.

During the rapid growth of the wheat crop in May and during the whole of the ripening period in August there is a great out-pouring of carbon dioxide. This is produced at the expense of the oxygen in the soil air. It is easy to understand the great production of carbon dioxide in May. This is associated with the intense biological activity in progress in the soil at this period. It is not so easy to understand why so much oxygen is required during ripening and why so much carbon dioxide is produced. In India, experience teaches us that crops never ripen properly if the soil-aeration is interfered with during this period. A part of the explanation is probably to be found in the fact that the fine roots begin to die and decay after the flowering period but this does not explain why the crop will not ripen unless air is supplied. The changes in the soil air during the life of the crop have so far not been investigated in India. A splendid field for applied research lies untouched which is bound to yield a rich harvest of results.

IV.—SOME OTHER ASPECTS OF SOIL-AERATION.

It follows that if soil-aeration is a growth factor, aeration must influence the distribution of plants * and prove to be of importance in ecological studies. Attention is now being paid to this aspect of the subject and results are beginning to appear. In the United States, Professor Cannon of the Desert Laboratory in Arizona and Professor Free of the Johns Hopkins University find that an inhibition of root growth is caused in numerous plants by a decreased amount of oxygen in the soil atmosphere†. The poor conditions of soil-aeration are correlated with the absence of vegetation in the dry lakes of desert basins and the zonation of vegetation around these basins is possibly in correlation with the different soil-aeration requirements of the plants involved. Professor Cannon intends to visit India and to pursue his studies in this country.

* The distribution of gram in India is correlated with soil-aeration. See *Agr. Jour. of India*, Science.Congress Number, p. 20, 1917.

† Cannon, W. A., and Free, E. E., *Jour. of Ecology*, V, p. 127, 1917.

In India, also, Mr. Hole has shown that soil-aeration is an important factor influencing the distribution of woodlands and grasslands. As regards the general importance of soil-aeration in Indian forestry, Mr. Hole has kindly promised to place his views before the Congress.

PART II—WITH SPECIAL REFERENCE TO FORESTRY.

1. Mr. Howard has just emphasized the importance of soil-aeration in Indian agriculture and I hope to convince you that it is no less important in Indian forestry.

2. As we frequently have great difficulty in quickly establishing a vigorous growth of seedlings in our valuable Sal (*Shorea robusta*) forests, a study of the factors influencing germination and the development of seedlings was commenced at Dehra Dun in 1909. Preliminary pot experiments carried out in 1909-10 showed that whereas it was practically impossible to injure Sal seed or seedlings by watering in sand, into and through which water percolated rapidly, germination could be materially reduced and the seedlings rapidly rendered unhealthy in water-retaining loam and leaf-mould by keeping the soil constantly moist. It was immaterial whether this moist condition was produced by the addition of water to the soil or by diminishing the loss of water from the soil through evaporation or percolation. The injurious action was most severe in the leaf-mould which contained considerably more organic matter than the loam.* Similar results were subsequently obtained with loam taken from a local Sal forest.† In the latter soil the injurious action can be strikingly demonstrated by growing the plants in non-porous glazed pots, the drainage holes at the base of which are subsequently closed by corks, when the seedlings are well established. In such cases, while evaporation can take place freely from the surface of the soil, no evaporation is possible from the sides of the pots and the water falling on the soil surface accumulates at the base of the pot, thus forming an artificial water-table at the base of the pot.

* *Indian Forest Records*, V. 4, Part I, pp. 17, 19 (1914).

† *Loc. cit.*, p. 30.



Photograph taken 20th September, 1915, showing Sal seedlings growing in Sal-forest loam.

Note the healthy growth in the uncorked pots 7 and 9 as compared with that in pots 6 and 8 which were corked on 30th July, 1915.



Fig. 1. Several of the Sal seedlings in pots 14 and 19 have shed their leaves as a result of placing dead Sal leaves on the surface of the soil. In pots 15 and 18 to which no dead leaves were added the seedlings are quite healthy. Photograph taken $3\frac{1}{2}$ months after the dead leaves were added.



Photo.-Mechl. Dept., Thomason College, Roorkee.

Fig. 2. Photograph of the pots shown in Fig. 1. above, taken one month later. Nearly all the seedlings in pots 14 and 19 have now shed their leaves.

In such cases, when the pots are placed in full sunlight in the open and supplied only with the local rainfall, the seedlings begin to get unhealthy in about ten days and, unless the conditions are altered, eventually die.

Plate 9 shows Sal seedlings growing under these conditions, pots 7 and 9 being uncorked while 6 and 8 have been corked for 52 days. Previous to corking, the number of healthy plants in 7 and 9 was exactly the same as that in 6 and 8. Note the healthy plants in 7 and 9 as compared with those in 6 and 8.* Similar results can, however, be produced by a procedure which to some extent is the reverse of the above, *viz.*, by opening the drainage holes at the base of the pots and then retarding evaporation from the upper soil surface by covering it with a layer of dead leaves.

For the purpose of this experiment seed is sown as before in the glazed pots, the drainage holes at the base of which are left open. When healthy seedlings have been thoroughly established, the surface of the soil in some pots is covered with a layer of dead Sal leaves while no such covering is placed in the control pots. If the soil is then kept moist in all the pots, either by artificial watering or natural rainfall, the seedlings in the pots with dead leaves soon become unhealthy. Plate 10, Fig. 1, shows examples of such plants, 14 and 19 are pots with dead leaves on the surface of the soil while 15 and 18 are pots with no dead leaves. When the dead leaves were placed in position there were 39 healthy plants in the former and 37 in the latter. The photograph was taken $3\frac{1}{2}$ months afterwards, and it will be seen that a number of the plants in the former have shed their leaves. Plate 10, Fig. 2, shows the same plants a month later when nearly all the plants in pots 14 and 19 had shed their leaves. It is interesting to note that if the pots are filled with sand instead of forest loam no injurious effect is produced by the dead leaves. Plate 11, Fig. 1, shows Sal seedlings growing in sand, pot 23 has dead leaves on the surface while pot 22 has no dead leaves. This photograph was taken $3\frac{1}{2}$ months after the leaves were placed in position and

* *Indian Forest Records*, V. 4, Part III, p. 90 (1916).

no injurious effect had been produced. In these experiments the layer of dead leaves was six leaves thick which is roughly equivalent to the annual leaf-fall in a well stocked natural forest.

3. Simultaneously with these pot experiments, a series of experiments have been carried out in the Dehra Dun Sal forests. These have shown that, whereas in the shade of the forest germination and seedling development during the rains is uniformly poor, even when the soil-covering of dead leaves is removed and the soil dug, excellent seedling growth can be obtained if the trees are felled in narrow strips or small patches and the seed then sown in the clearings where the soil is exposed to the sun and air. In the former case the soil invariably contained more water and organic matter than in the latter and the unhealthy seedlings invariably showed more or less extensive rotting of the roots. That the injurious agent is here a soil factor and not deficient light is clearly shown by the fact that if pots containing sand are placed in the shade of the forest healthy seedlings with well-developed roots can be produced in them without difficulty. Plate 12, Fig. 2, shows the development of Sal seedlings in a cleared patch 60 ft. in diameter and Plate 12, Fig. 1, shows the corresponding development in the shade of the adjacent forest, respectively. In both cases the seedlings are two years old.*

4. In all the experiments noted above, both in the pot cultures and in the forest, the symptoms shown by the unhealthy seedlings are the same. The first sign of disease is seen in the blackening and death of the tender root tips and rootlets the damage then spreading, unless the conditions are ameliorated, until the entire root-system becomes black and rotten. It is significant that above ground the seedlings may appear quite healthy with green leaves when a number of the deeper roots are dead and rotten. This appears clearly to indicate that the injurious agent is a soil factor and the symptoms convey the impression of a localised poisonous action rather than of a general starvation effect due to lack of essential food materials. Above ground the first sign of trouble is seen in the leaves turning pale and

* *Indian Forest Records*, V. 4, Part II (1916).

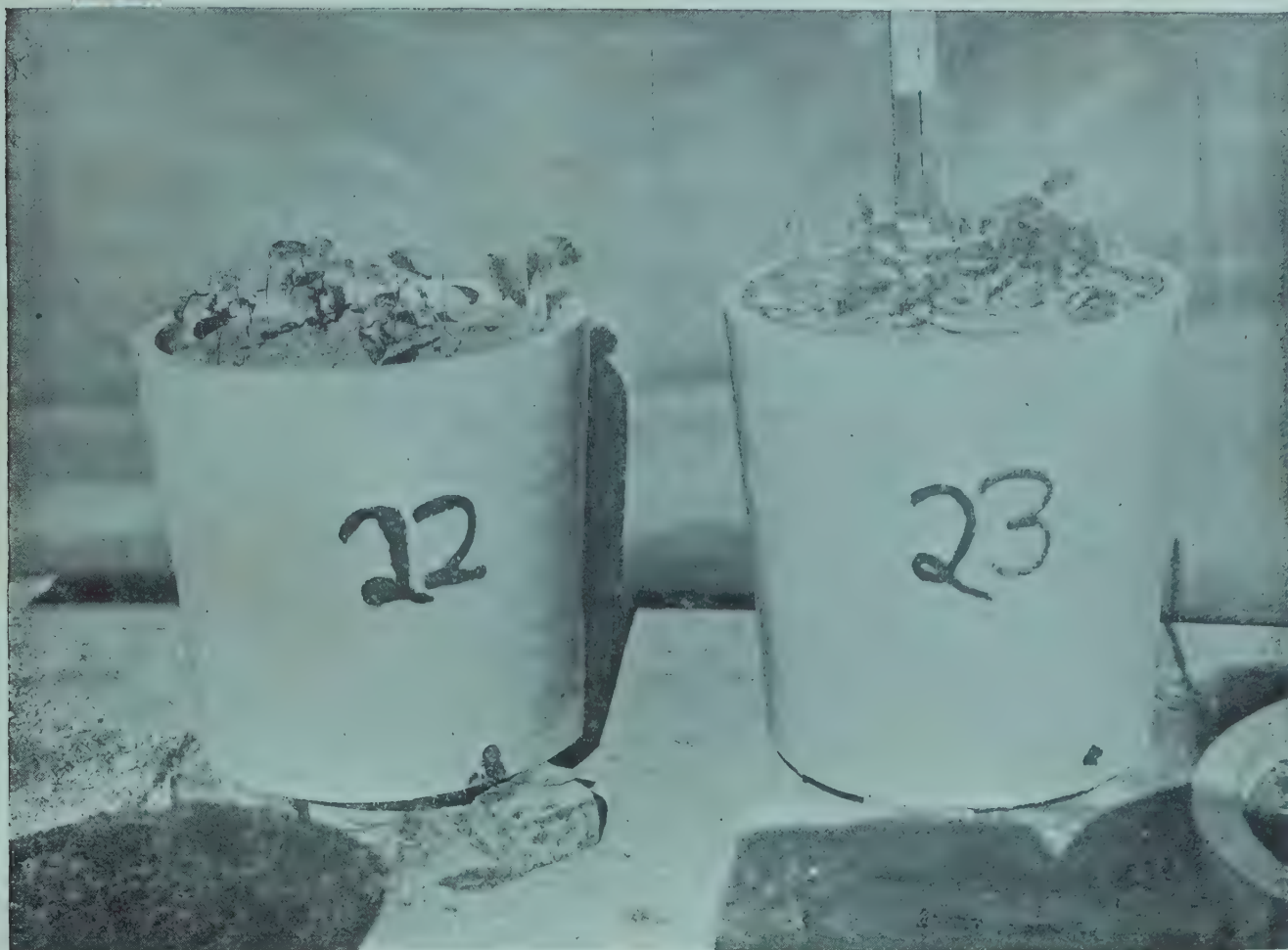


Fig. 1. Photograph of healthy Sal seedlings growing in sand, taken $3\frac{1}{2}$ months after a layer of dead Sal leaves had been placed on the surface of the soil in pot 23. No dead leaves were added to pot 22. No injurious effect has been produced by the dead leaves.



Photo.-Mechl. Dept., Thomason College, Roorkee.

Fig. 2. Photograph of Sal seedlings taken 13 days after the basal drainage holes had been corked in the two pots on the right. In these pots the seedlings are showing the first signs of trouble from bad soil-aeration, the leaves hanging vertically downwards. In the two pots on the left which were not corked the seedlings are healthy with leaves horizontally extended.



Fig. 1. Forest shade plot V. Photograph taken 20th July, 1915. Note the appearance of the 2-years-old seedlings surviving in the plot.



Photo.-Mechl. Dept., Thomason College, Roorkee.

Fig. 2. Forest Plot IV. An area 60 ft. in diameter was here clear-felled in May, 1913. The photograph was taken on 20th, July, 1915. Note the vigorous 2-years-old seedlings surviving in the plot.

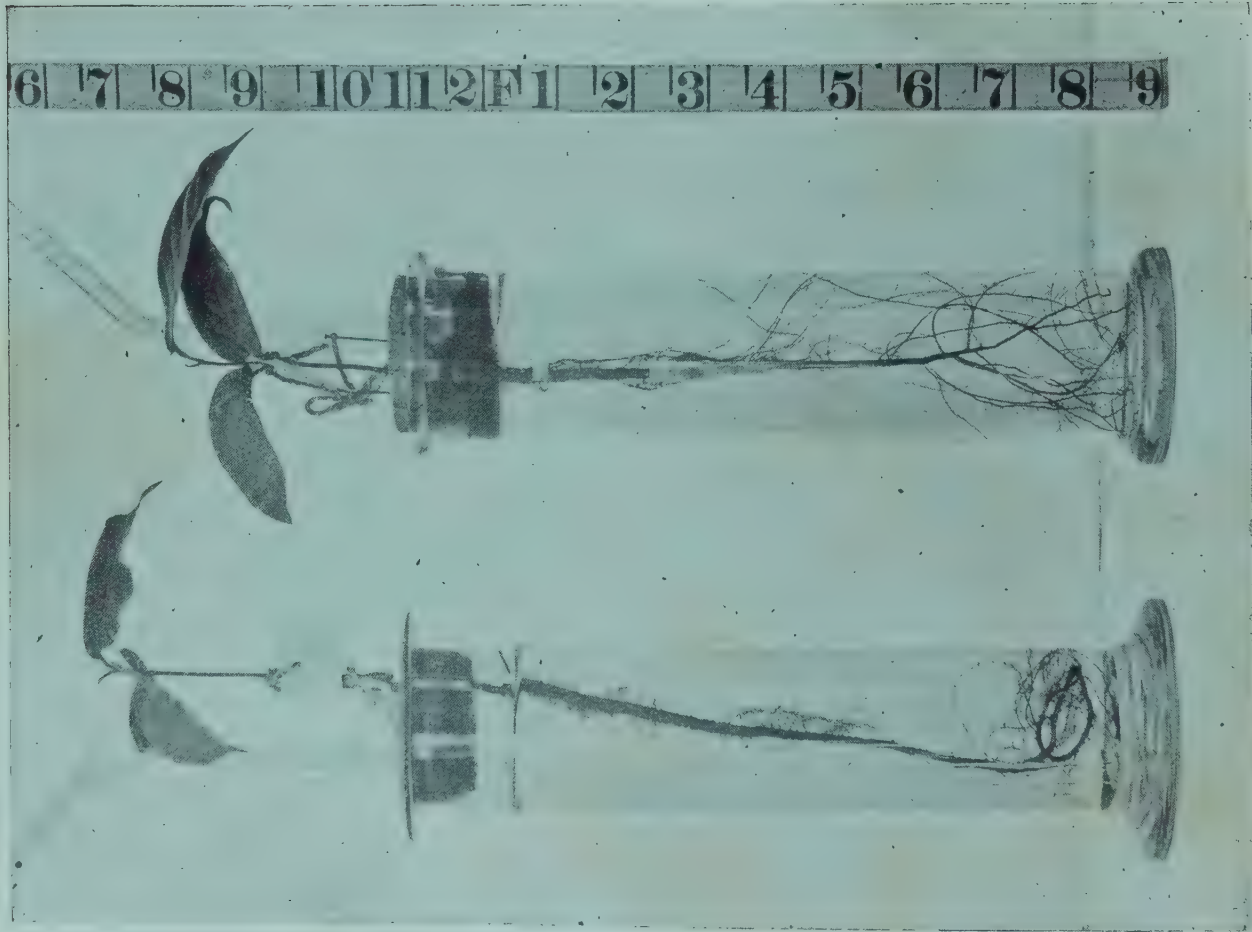


Fig. 1. Sal seedlings which have been growing in a water-culture solution for 4 months and which show a vigorous development of healthy roots, especially near the apex.

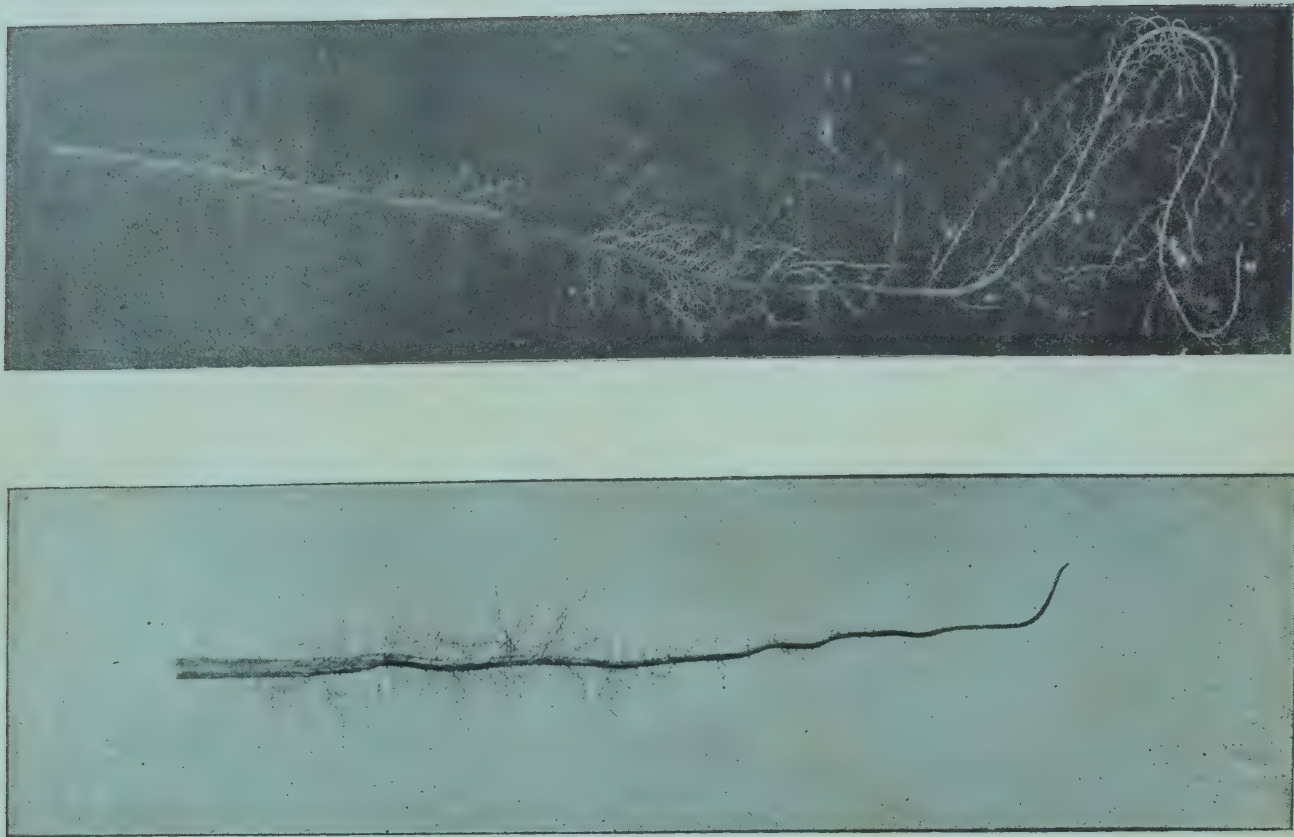


Fig. 2. Showing the root-systems of two Sal seedlings which have been grown in water-culture for 19 days. The one on the right is healthy, showing numerous healthy young roots, and was grown in an aerated solution, while the one on the left has been gassed for 2 minutes daily, the concentration finally attained being 600 Mg. CO_2 per litre of water. In this case the root is dead at the apex and

hanging vertically downwards instead of remaining horizontally extended. Plate 11, Fig. 2, shows healthy seedlings in the two pots on the left and, in two pots on the right, those showing the first signs of trouble from bad soil-aeration, 13 days after the pots had been corked. The leaves eventually turn brown and drop off. Organisms such as bacteria and fungi are usually absent from the diseased roots at first but may invade the damaged tissue later. It must be noted that the injurious factor may and indeed usually does cause severe damage in a soil which, although being moist, is still far from being in the condition usually associated with the term "water-logged." Experiment has shown that 100 per cent of Sal seedlings may be killed or seriously damaged by this factor when no water is standing on the surface of the soil and when there is a considerable water-free air-space near the roots. Again, although a moist condition of the soil undoubtedly increases the injurious action, it can be easily shown by water-culture experiments that water in itself cannot be the injurious factor. In Plate 13, Fig. 1, are seen Sal seedlings which have been growing in a water-culture solution for four months and which show a vigorous development of healthy roots especially near the apex. As a general rule, no difficulty is experienced in growing healthy seedlings in this way when air is allowed access to the culture solutions.

5. In 1915, an experiment carried out at Dehra Dun showed that when water was held in contact with the Sal forest loam mentioned above in glazed non-porous pots it became heavily charged with CO_2 and impoverished as regards its supply of dissolved oxygen. In 1916, a further experiment showed that when rain-water, with an initial content of 1 milligram CO_2 and 7 milligrams oxygen per litre, was held in contact with this soil in glazed non-porous pots which were placed in full sunlight in the open, the CO_2 rose to from 60—70 milligrams in two days while the oxygen fell to 1 milligram. After 28 days the CO_2 rose to 230 milligrams. These changes took place in soil in which no plants were growing and were, therefore, apparently due chiefly to the activity of the living organisms in the soil. The diagram given on the next page indicates the change in the

dissolved gases observed in rain-water which was kept in contact with this soil for 19 days in corked glazed pots which were placed in the shade and in which Sal seedlings were growing. In this case, the water added to the pots had an initial content of 4.8 milligrams oxygen and 5 milligrams CO_2 and the diagram shows that in 19 days the CO_2 had risen to 163 milligrams, this increase being correlated with a fall in the oxygen content which, at the end of the period, was 1.2 milligrams per litre. At the close of this period, in 95 per cent. of the Sal seedlings growing in these pots the roots were completely dead and rotten.

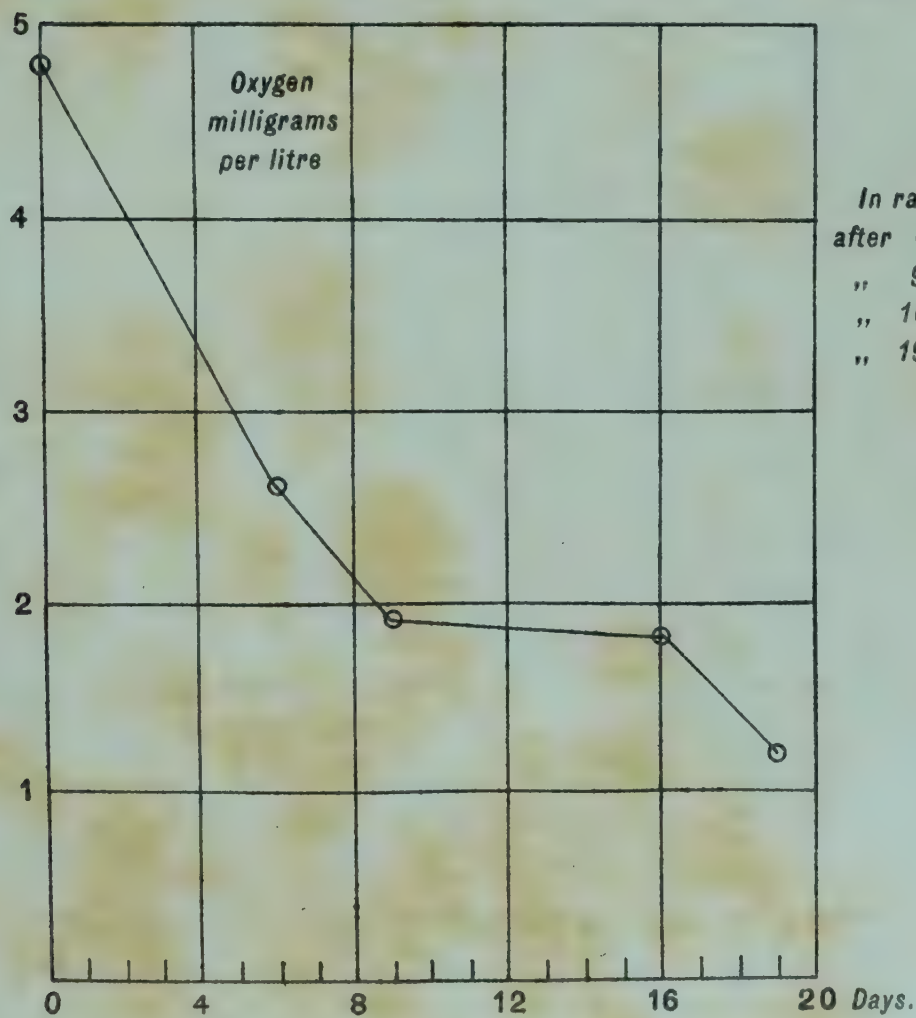
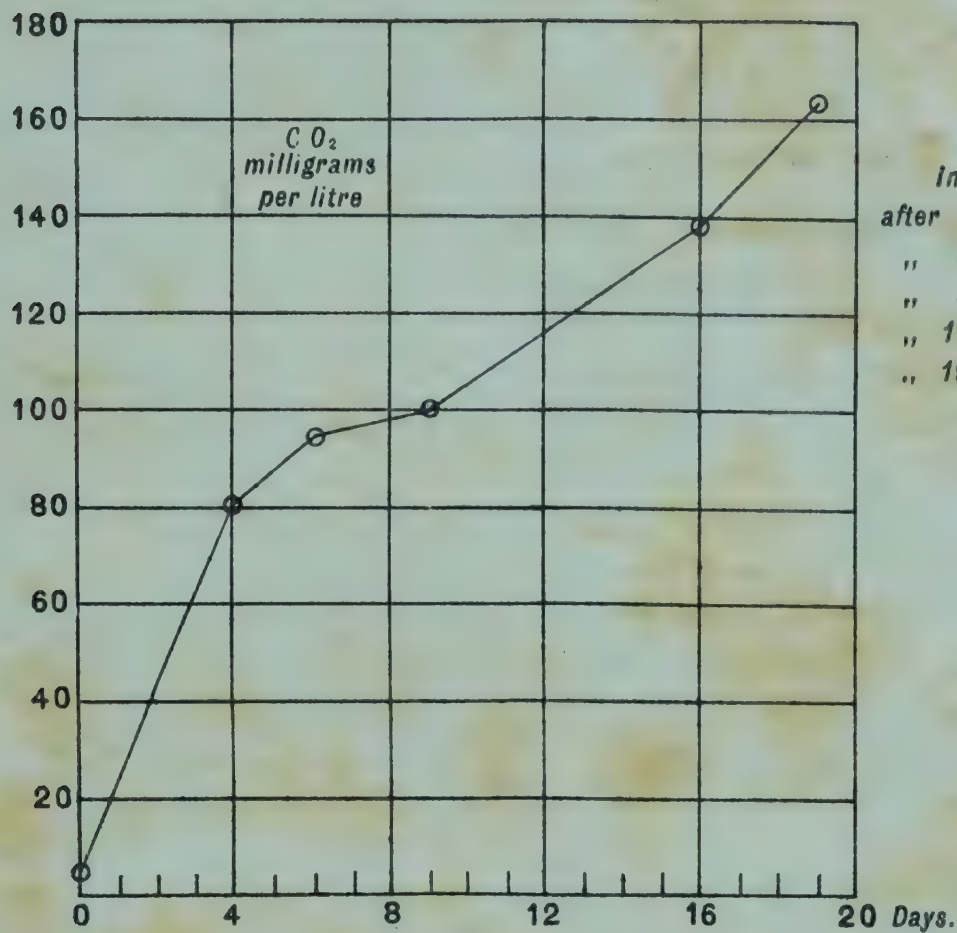


Diagram showing changes in the dissolved gases found in rain water which was held in contact with Sal-forest loam for 19 days in corked pots.

All the figures quoted above represent the quantities of these gases which were found dissolved in the percolation water drawn off from the base of the pots. So far as our experiments, therefore, have gone at present they show that the injurious action on the roots of *Sal* seedlings is associated with a very small oxygen and high carbon dioxide supply. That a deficiency of oxygen may be injurious to roots is usually accepted by physiologists and is indicated by such water-culture experiments as the one quoted by Mr. Howard. The effect of this factor on the roots of *Sal* seedlings still requires to be investigated.

The effect of various quantities of CO_2 gas on these roots, however, has been tested by us, simultaneously with the pot experiments mentioned above, by growing the seedlings in water-cultures and bubbling the gas through the culture solutions.

So far as these water-culture experiments have gone at present they show that, when the concentration of the gas reaches roughly 500 milligrams per litre and above, the delicate root-tips and rootlets of vigorous *Sal* seedlings are blackened and killed and the production of new roots is inhibited, the appearance of the damaged roots resembling that of those found in badly aerated soil. Plate 13, Fig. 2, shows the root system of two *Sal* seedlings which have been grown in water-culture for 19 days. The one on the right is healthy and was grown in an aerated solution, while the one on the left has been gassed for two minutes daily, the concentration finally attained being 600 milligrams CO_2 per litre of water.

The fact that the concentration required to produce this injurious effect in water-cultures is considerably higher than that which exists in the percolation water taken from pots in which *Sal* seedlings are suffering severely from the injurious factor would appear, at first sight, to put CO_2 out of count as a possible cause. It is believed, however, that this conclusion is not yet justified. During these culture experiments it was noticed that those roots which happened to be near the exit of the gas tube were blackened and killed when those further away still remained uninjured and also that healthy roots were often produced near the upper surface of the solution which was in contact with the air and farthest removed

from the gas tube mouth while the roots deeper down were obviously unhealthy. It is believed that differences in concentration of this kind are even more marked in the soil than in water-cultures such as those dealt with above. It thus seems possible that extensive damage may be done to the roots when the concentration of CO_2 in the mass of the percolation water filling the pore space in the soil is too weak to cause injury. It must also be remembered that in badly aerated soil there are apparently always two injurious actions at work together, *viz.*, a deficiency of oxygen and an excess of CO_2 and it is probable that the injurious action of CO_2 depends largely on the quantity of oxygen available.*

There is reason to believe that a deficiency of oxygen is in itself injurious to the roots while such a deficiency appears to be invariably correlated with an accumulation of CO_2 and possibly also of other poisonous substances. At present, therefore, it seems probable that the most reliable indication of the conditions of aeration in the soil will be obtained by determining the quantity of oxygen and CO_2 existing in the soil and that we may define a badly aerated soil as one in which there is a deficiency of oxygen and an excess of CO_2 .

To determine whether this is correct or not, further extensive experiments are required in which determinations of these gases should be correlated with careful observations on the root growth. In forestry it is important that we should be able to determine quickly when the conditions of soil-aeration are becoming unsuitable for the healthy development of our trees so that the treatment may be altered without undue loss of time and before serious damage has been done. Analysis of the soil gases at present promises to be the best means of effecting this and it is with the hope that the attention of some of those eminent chemists who are present here to-day may be attracted to the subject and that they will help us to elaborate easy and practical methods of soil-gas

* Thus Kidd has shown that, with 5 per cent oxygen, 9—12 per cent. carbon dioxide inhibits the germination of seeds, whereas, with 20 per cent. oxygen, 20—25 per cent. carbon dioxide was required to produce inhibition with a temperature of 17°C . (*Ann. Bot.*, XXXI, p. 457, 1917.)

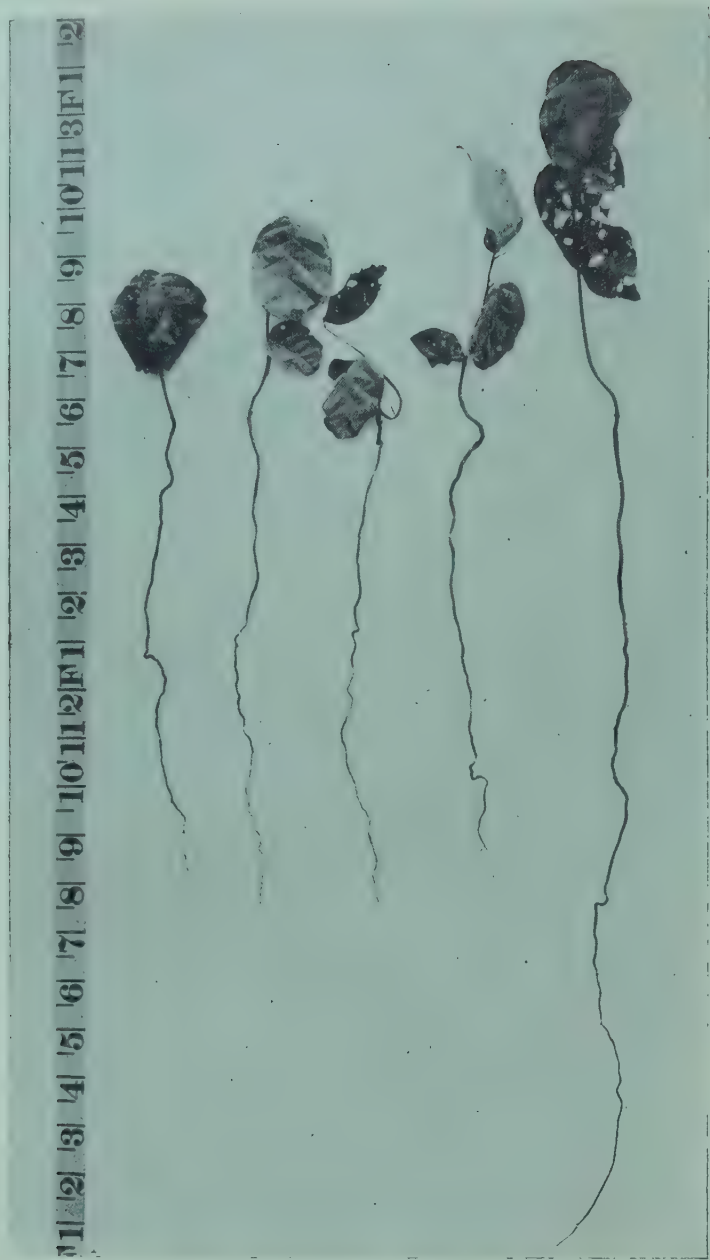


Fig. 1.



Fig. 2.

Showing the root-development of Sal seedlings at the end of the first rains ;
in fig. 1, plants which have been grown in porous well-aerated loam and,
in fig. 2, plants which have been grown in dense badly aerated loam.

analysis suitable for application in the forests that the present paper has been written.

6. From what has been said above it will be seen that soil-aeration apparently depends chiefly on:—

(1) The amount of water in the soil.

(2) The amount of organic matter in the soil.

(3) The number and kind of soil organisms.

(4) The rate at which currents of air, or water with oxygen in solution, penetrate into and percolate through the soil.

In the Sal forest loam used in the pot experiments mentioned above, bad aeration appears to depend chiefly on the first three of these factors, but experiments have shown that soil texture and rate of percolation are no less important. Plate 14, Figs. 1 and 2, show the growth of Sal seedlings of the same age in porous and dense loam respectively. In the latter the time required for $\frac{1}{2}$ inch of water to penetrate below the surface was 750 seconds, whereas in the former it was 46 seconds. Note the respective root growth of the seedlings in the two cases. In dense soil germination is reduced, more seedlings die during the rains of bad aeration and of drought during the dry season owing to poor root development.

7. It is important to note that the various agencies which influence soil-aeration can be controlled to a considerable extent by ordinary forest operations apart from the obvious but expensive methods of draining and soil cultivation. Thus the quantity of water, of soil organisms and of organic matter can be regulated by varying the shade and quantity of dead leaves added to the soil and also by the controlled use of fire. Texture is also influenced by the amount of organic matter in the soil and also by such factors as the grazing of cattle, both of which are capable of regulation. In some cases the temporary encouragement of the growth of certain grasses and other herbs, the roots of which are much sought after by such forest cultivators as rats and pigs, is an important factor in improving soil texture. The felling of trees and the subsequent decay of the subterranean roots is also an important

factor in influencing soil-aeration, a point which has recently been emphasized by Mr. Howard. There is thus good reason to believe that, provided we can elaborate a method, by soil-gas analysis or otherwise, of quickly and accurately identifying a condition of bad soil-aeration, we shall, at any rate in many cases, be able to apply the necessary remedy.

8. As regards the general importance of soil-aeration in Indian forestry, it must, I think, be accepted that this factor is of primary importance in the case of the Sal, the only species which, up to date, has been studied in any detail in this connection and regarding which our knowledge is still very imperfect. In the moist forests of Dehra Dun it has been shown that the establishment of seedling growth depends primarily on this factor and Mr. R. S. Troup has recently shown that this is also the case in the moist Sal forests of Bengal and Assam.* In the latter case it is interesting to note that subjecting the forest to fires is now said to be improving the seedling growth. Apart from the question of the establishment of seedlings, Mr. R. G. Marriott has recently ascribed the poor development of older trees to this factor and suggests that, owing to it, the trees may practically cease to grow during the rains which ought to be the period of most vigorous growth.†

Finally, it is interesting to note that, although the Sal root-fungus *Polyporus Shoreæ* is widely distributed throughout the Sal forests of India, so far as is known at present, it only causes serious damage in those wet forests of Bengal and Assam in which the conditions of soil-aeration are known to be particularly unfavourable. Bad soil-aeration by producing a diseased and sickly condition in the roots may be a factor of great importance in facilitating the attacks of injurious root-fungi of this class. It is interesting to note from an œcological point of view that the natural distribution of the Sal appears to be regulated largely by this factor. Thus good Sal forests are not known to occur on really wet soils unless these soils consist chiefly of gravel and sand. On loam the best Sal forests are limited, so far as we know at present, to those

* *Note on the Forests of the Duars, Simla*, 1915, p. 36.

† *Indian Forester*, Vol. XLIII, p. 444.

areas which are well drained and where the soil texture is good. These facts of distribution accord precisely with the results of the Dehra Dun pot experiments which have shown that whereas on well-aerated sand it is practically impossible to give too much water to Sal seedlings, the latter are very susceptible to injury by bad soil-aeration in loam.*

There is good reason for believing that several other species of our most valuable Indian trees are no less susceptible than Sal to the influence of soil-aeration and, speaking generally, there can be little doubt that this factor is of great importance in Indian forestry whether considered with reference to its effect on the healthy growth and development of seedlings and trees or its possible connection with injurious diseases or, finally, with regard to its œcological importance in influencing the distribution of species and types of vegetation.

9. Before leaving this subject I venture to suggest that the following, which of recent years have attracted much attention, may possibly be found to be primarily cases of bad soil-aeration. Pickering's experiments at Woburn have demonstrated the injurious effect of grass on fruit trees which has been attributed to the presence in the soil of a toxin which is either produced directly by the grass roots or from the organic remains of such plants. A dense growth of grass is correlated with an accumulation of dead roots, leaves and other débris in the surface soil which would ordinarily encourage the rapid reproduction of the soil organisms engaged in the decomposition of organic matter. We should naturally expect that rain-water, percolating through such a layer of grass, would tend to be deprived of the oxygen by the numerous living grass roots and soil organisms and would become heavily charged with CO_2 . Pickering notes that when such "toxic" water is exposed to the air, for 24 hours, its toxic property is found to have entirely disappeared.† Exposure to the air would tend

* That soil-aeration influences the distribution of types of vegetation other than Sal forest is indicated in *Indian Forest Memoirs, Bot., Vol. I, 1, p. 46* (1911), and in *Indian Forester*, XLII, p. 344 (1916).

† *Annals of Botany*, 31, p. 184 (1917).

to make good a deficiency of oxygen and to dissipate an accumulation of CO_2 by diffusion.*

The work of Russell and others at Rothamsted has shown that in soils which are kept moist, warm, and richly supplied with organic matter plant growth is frequently unsatisfactory and this is correlated with an exceptional development of the larger soil organisms such as protozoa. May not this unusual development of large organisms be responsible for a deficiency of oxygen and an accumulation of carbon dioxide, and thus for a condition of bad soil-aeration?

10. In conclusion, although I have enjoyed the privilege of putting these points before the members of the Science Congress it must not be thought that I, personally, can claim the credit for such results as have already been obtained. For the recognition of the importance of soil-aeration in practical forestry we are indebted to the careful observations of forest officers like Messrs. R. S. Troup and R. G. Marriott, while as regards the experimental work carried out at Dehra Dun the lion's share, including all the chemical work, has been done by Mr. Puran Singh, our Chemical Adviser, and his assistant, Mr. T. P. Ghose, who have carried this through under great difficulties and under constant heavy pressure from other duties.

FORESTRY IN LOWER BURMA.

BY H. W. A. WATSON, I.F.S.

Referring specially to Zigôn division, I consider that Forestry in Lower Burma suffers from four grave handicaps:—

- (1) The so-called Selection system.
- (2) The outlying plains reserves.
- (3) The lack of system under which Improvement fellings are carried out.
- (4) The dread of the Kyathaung bamboo flowering.

* Mr. Howard made a similar suggestion in 1915, see *Soil Ventilation*, *Pusa Bulletin No. 52*, pp. 22, 23.

2. To take these seriatim :—

The so-called Selection system was evolved at a time when the staff was inadequate for supervision. It is admittedly rough and inadequate, and it is hard to realize why to date it has not been replaced by a more rational system. Where only certain species in a mixed forest are saleable, any system of selection which bears only on one, or possibly more, species forming a small percentage of the crop, must logically result in a great reduction in the stock of the species exploited. The counterpoise was to have been Improvement fellings ; but so far these have been carried out unsystematically and, apart from this, have failed to keep pace with extraction. Of late years, the introduction of the Uniform method has been under consideration ; but our moves in this direction have been desultory and on the whole negligible in results.

3. The comparatively small outlying patches of plains reserves constitute an embarrassment in that they distract our attention from what should be the primary object, *viz.*, the proper silvicultural management of the large block of Yoma reserves. These plains reserves are situated on land that is eminently suited for permanent cultivation. Their environs are thickly populated and their adequate protection from organized theft is, under existing conditions, almost an impossibility.

The grounds for their maintenance are that the agriculturist must have timber at his door-step. The distance from the railway line to the edge of the Yoma reserves, as yet practically untapped for timber other than teak, is roughly 12 miles. A rational policy for working these plains reserves would be to work them out by coupes during a period of, say 30 years, abandoning each coupe to cultivation as worked out and to put the profits from their disintegration into roads to render the vast resources of the Yoma reserves readily accessible.

4. Improvement fellings have been classified in two grades : "O" fellings for the improvement of the existing stock and "Y" fellings to induce or aid regeneration. Where, as usually is the case, the produce felled is unutilizable and unsaleable the operation is economically unsound.

"O" fellings progress annually by square miles; but, except in rare cases where groups of valuable species are freed, the results are barely worth the paper they are described on. "Y" fellings progress annually by acres (in Zigôn division there have been none so far). Their cumulative effect as compared with the total area of reserves is so fractional as to be almost negligible.

The most striking feature, however, of many Improvement fellings is that they appear to be carried out without any clear object being aimed at. Their general object should be the creation of a homogeneous crop over as large an area as possible. Yet the primary essential to produce this, namely, the careful use beforehand of a preparatory extraction of the saleable species that are overmature or interfering with promising groups is almost invariably omitted. This omission is equally obvious in the case of compartments, that are heavily planted over.

5. Interwoven with the question of Improvement fellings is that of the flowering of the Kyathaung bamboo which is expected to take place in the near future. Theories and orders on the subject of our action in this contingency have been flying round for the past twenty years or more. It is anticipated that the combined results of Providence and our efforts during this flowering will enormously enhance the value of our forests. In fact, we gamble on being able, at a single coup, to accomplish more than could be done by at least a decade of steady endeavour. We disregard the fact that other bamboo species have flowered periodically in the past over many square miles without our having succeeded in gaining any appreciable advantage by the phenomenon. The results from the Kyathaung flowering will probably be likewise and the less we expect from it the better. There is, as a rule, practically no advance growth under Kyathaung and inducing such is handicapped over much of the area by a dense growth of seedlings of other species of bamboo while weeds will spring up as soon as the cover is opened up. Whereas in the case of other bamboos that have flowered gregariously good patches of advance growth were the rule rather than the exception. In short, I think that taking advantage of the Kyathaung flowering is going to be too big a job for us to tackle.

and instead of gambling on it, I would favour efforts to progress steadily on more assured lines.

6. A very neglected factor for the improvement of our forests is the 'taungya' cutter. This individual has made up his mind that he must live by cutting down jungle and planting crops in the clearings. At one time his efforts were extensively utilized for making teak plantations; but a policy arose which discouraged the extension of these plantations. The grounds were that we had not the staff to tend them properly. This was a pity as such plantations, if concentrated, are little harder to tend than regeneration induced by Improvement fellings and even inadequately tended, the fact remains that they replace a useless with a useful growth. The effort to get a high percentage of success has been the curse of plantations in the past.

The controlled 'taungya' cutter felling and burning the useless species to produce a field crop mixed with teak is economically accomplishing more than results from our "Y" fellings which, producing less teak and no field crop, make no greater annual progress in area than would concentrated 'taungya' plantations.

It may be argued that the 'taungya' cutter may raise difficulties about our control. A little careful cultivation of the individual combined with where possible a little pressure will accomplish much in dealing with him. There is no getting over the fact that our policy starting from the year 1897 of reducing 'taungya' plantations did much to discourage the 'taungya' cutter and was in many cases grossly unfair to him. He had planted for us for a number of years and we dropped him without warning when the administration imagined it suited them to change the policy. We had even induced some of the Pegu Yoma Karens—a conservative and obstinate race—to plant for us and we dropped them without consideration. However we may revile the 'taungya' cutter, the fact remains that in dealing with him we have not been conciliatory or in many cases even fair. Of recent years (the policy at the time the Pegu Yoma reserves were formed was otherwise), we have consistently treated him as an enemy.

7. This preamble leads up to my suggestions for our future silvicultural policy. Summarized these are :—

(i) Classify our forests into zones for regeneration purposes as follows :—

(a) Accessible to the extraction of (i) the heavier timbers or (ii) bamboos.

(b) That can be made accessible to such extraction within the time required to regenerate (a).

(c) That although at present inaccessible to extraction, can be planted up by the agency of 'taungya' cutting villages in the vicinity.

(d) Other areas.

(ii) Treat Burma as a whole and colour in zones (a) and (c) on our maps as our first period under the Uniform method.

Regenerate (a) by Improvement fellings combined with planting, if necessary after the removal of the marketable species.

Regenerate (c) by the 'taungya' method.

The areas covered by (a) and (c) in the whole of Burma will probably be so great that the question of regenerating zones (b) and (d) need hardly trouble the present generation. In divisions where such areas are wanting they could doubtless be created by improving communications and the establishment of forest villages. It is thought that in such divisions money should be put into communications rather than into Improvement fellings; but it seems best to treat Burma as a whole and, if funds are inadequate, scrap temporarily inaccessible divisions rather than diffuse our efforts.

(iii) Limit Improvement fellings outside the areas under regeneration to the destruction of creepers and ficus except in the rare cases where we can free groups of young stock; but such work should be considered absolutely secondary to work to be done under (ii).

At the same time keep always in view the question of bringing zones (*b*) and (*d*) into zones (*a*) and (*c*).

In brief, cease or modify our present irresponsible policy of wasteful extermination by so-called Improvement fellings of species that we consider useless in favour of a policy for utilizing such species as far as possible in accessible areas, as timber by concentrated extraction and in the less accessible areas, as nutriment for crops by concentrated regeneration on the 'taungya' method.

The Uniform system with regeneration on the French "Quartier bleu" system is indicated.

NOTE ON JUNGLEWOOD SHINGLES.

BY J. D. HAMILTON, PROVINCIAL FOREST SERVICE.

Owing to the prevailing exorbitant prices for corrugated iron-roofing, an old-time industry of hand-sawn shingles is being somewhat revived at Taungdwingyi, Magwe, Upper Burma. As an all-round roofing material, shingles are superior to corrugated iron in that they make a much cooler roof and may last as long, if not longer. The reasons for corrugated iron having been used in the past more extensively than shingles were:—(1) The comparative ease with which it could always be obtained in local bazaars and erected. (2) The lower cost of a roof made of the inferior kinds of corrugated iron as compared with the Rangoon price of teak shingles—the only real competitor in the market. If shingles and battens could be made readily available to the public at a price to compare with corrugated iron, there can be no doubt that shingles would replace the iron, as the latter must have a ceiling for a dwelling house while a Burman can live under a plain shingle roof without inconvenience. Corrugated iron also does not last well where wood smoke gets to the roof as the acid fumes soon destroy the zinc coating and then rust eats away the iron. Every corrugated iron kitchen roof is evidence of this.

At the present time the cost of corrugated iron is more than double what it was before the war and often cannot be procured

at all. The moment is hence eminently favourable for the introduction of shingles on a large scale to capture the market. And once captured it could be held for years, as it will be a long time before corrugated iron will again be able to appear as a competitor.

2. *Method of sawing shingles by hand at Taungdwingyi.*—

Scantlings are cut from the round log so as to have a side of the width of the shingle required (usually 5 inches) and some multiple of $1\frac{1}{8}$ inches for the other side. (The $\frac{1}{8}$ inch is an allowance for saw-cuts and the thickness of two shingles make an inch.) The scantling is then marked out into shingle lengths of 14 or 15 inches, as required, and the first length is sawn into as many one inch planks as the scantling will yield, producing a comb-like division of the wood. Each plank or tooth of the comb is then sawn diagonally along its length into halves having a $\frac{1}{4}$ inch thickness at one end and $\frac{3}{4}$ at the other, *i.e.*, into two shingles. After each plank or tooth has been so treated, all the shingles are sawn off at right angles to the scantling and the next length cut into planks and diagonally divided into shingles. The sawing throughout is done on the saw-pit in the usual manner by two men, and it is estimated that they turn out from 80 to 100 shingles per day. The sawing rate for all soft woods used is Rs. 7 per thousand. The shingles so sawn are of a uniform quality and about as regular as those turned out by machinery. The selling price of the shingles at Taungdwingyi is Rs. 22 per thousand. This refers to soft woods only. Teak shingles stand in another class altogether and deserve, and may receive, separate treatment. The junglewoods used for shingles are *kyunbo* (*Premna pyramidata*), weight 40 lbs. per c. ft., *kuthan* (*Hymenodictyon excelsum*), weight 30 lbs. per c. ft., *letpan* and *didu* (*Bombax malabaricum* and *insigne*), weight 28 lbs. per c. ft.

3. Shingles before use are boiled in a mixture of earth-oil and water in a proportion of about two to one for at least half an hour. An iron cauldron is used for the purpose and the addition of the water is said to minimize the risk from fire.

Such shingles properly treated with earth-oil last in Taungdwingyi from twenty-five to thirty years. There is much local

evidence of this. The woods *kyunbo*, *kuthan*, *letpan* and *didu* are not in themselves of a very lasting quality and their longevity in a shingle roof is almost solely due to the amount of earth-oil they absorb during boiling. *Kyunbo* and *kuthan* are somewhat superior to *didu* and *letpan* in that they are not attacked by borers even if not treated with earth-oil; but *didu* and *letpan*, on the other hand, seem capable of taking up more oil and so give equally good results when used as shingles. The woods used as battens in connection with the shingles are *kyunbo*, *kuthan*, *in* and one or two other light woods which are not attacked by borers. *Didu* and *letpan* could of course be used if boiled in earth-oil the same as shingles, before use.

4. *Cost of roofing 100 sq. ft. with shingles.*

	Rs.	a.	p.	Rs.	a.	p.
500 shingles at Rs. 22 per 1,000						
shingles	11	0	0
Earth-oil for 500 shingles	1	4	0
240 r. ft. battens 2" x 1" at Rs. 2 per						
100 ft.	4	12	0
Labour	2	0	0 = 19 0 0

Cost of roofing 100 sq. ft. with corrugated iron sheets.

	Rs.	a.	p.	Rs.	a.	p.
6' x 2' at Rs. 100 per 100 sheets						
(minimum pre-war rate), ten						
corrugated iron sheets allowing						
3" for overlap	10	0	0
50 r. ft. battens 3" x 2"	3	8	0
Labour	1	8	0 = 15 0 0

In order, however, to make a corrugated iron roof habitable some form of ceiling is necessary. The cheapest ceiling in use is made of heavy bamboo matting attached to the rafters by means of laths.

Cost of 100 sq. ft. of ceiling.

	Rs. a. p.	Rs. a. p.
Battens 50 r. ft., $2\frac{1}{2}$ " \times 2"	... 2 12 0	
Laths 3" \times $\frac{1}{2}$ ", 100 r. ft.	... 1 12 0	
Matting ...	... 2 0 0	
Nails ...	... 0 8 0	
Labour ...	... 1 8 0 =	8 8 0

Cost of 100 sq. ft. corrugated iron roof with mat ceiling comes to Rs. 23-8-0 as against Rs. 19 for shingles. And even with the mat ceiling the corrugated iron roof is not so cool as the shingle roof nor does it present nearly such a pleasing appearance. The Burman too prefers the appearance of shingles.

If instead of the mat ceiling we add a plank ceiling, the cost of the ceiling alone comes to Rs. 24 per 100 sq. ft., and this added to the cost of the corrugated iron roof equals Rs. 39.

In these calculations, I have taken the very cheapest grades of corrugated iron at minimum pre-war rates. The same material is now selling at from Rs. 250 to Rs. 350 per hundred sheets at Taungdwingyi and, of course, there are only buyers of odd sheets to repair a former roof or meet some unlooked-for demand. The cost of a corrugated iron roof at the present moment would be about Rs. 39 per 100 sq. ft. without any ceiling. The time is hence eminently favourable to place a cheap and reliable roofing material on the market. But this cannot possibly be done by the local timber trader who has neither the means nor the business capacity to launch out on a large scale. The shingles and battens should be cut by machinery, not so much to lessen the cost of conversion as to increase the outturn and place the roofing material in all bazaars and markets. The shingles and battens should be thoroughly boiled in earth-oil before being sold so as to reduce the purchaser's labour.

I am of opinion that if this were done the demand would outrun the supply.

5. *The actual cost of producing shingles at Taungdwingyi.*—A *kyunbo* log 17 ft. long by 4 ft. 5 in. girth was selected and converted into shingles and battens. The log yielded 480 shingles and 144 r. ft. of 2" × 1" battens.

Expenses on the log were—

	Rs. as. p.	Rs. as. p.
Marking fee ...	1 0 0	
Royalty ...	1 0 0	
Felling and logging ...	0 8 0	
Carting to Taungdwingyi ...	4 12 0	7 4 0
<hr/>		
Cost of cutting 480 shingles at Rs. 7 per 1,000 ...	3 5 9	
Cost of cutting 144 r. ft. battens at Rs. 10 per 100 battens 18' × 2" × 1" ...	0 12 9	4 2 6
<hr/>		<hr/>
		11 6 6
The sale price of 480 shingles at Rs. 22 per 1,000 ...	10 9 0	
The sale price of eight battens, 18' × 2" × 1" at Rs. 35 per 100 ...	2 12 9	13 5 9
<hr/>		<hr/>
Profit ...	...	1 15 3

A large log would give somewhat better results and the average profit may be reckoned at about 20 per cent. on the outlay.

A point, however, which should not be lost sight of is that if the same log instead of being sawn into shingles were to be cut into planks 17' × 5" × 1," the yield would be 17 planks and 144 r. ft. of 2" × 1" battens.

	Rs. a.	p.	Rs. a.	p.
Cost of sawing 17 planks at Rs. 15 per 100 ...	2	8	9	
Cost of sawing 144 r. ft. battens at Rs. 10 per 100 battens 18' x 2" x 1" ...	0	12	9	3 5 6
Cost of log as above ...	7	4	0	10 9 6
Value of 17 planks 17' x 5" x 1" at Rs. 75 per 100 ...	12	12	0	
Value of eight battens 18' x 2" x 1" at Rs. 35 per 100 ...	2	12	9	15 8 9
Profit ...				4 15 3
or nearly 50 per cent. as compared with only 20 per cent. for shingles.				

6. It is evident, therefore, that converting logs into shingles is not the most economical way of utilizing timber. But far more shingles can be sold than planks, and the total possible earnings by cutting the former far exceed all possibilities with the latter. The cost of carting (Rs. 12 or more per ton) makes it impossible to develop the industry at Taungdwingyi. It should be started somewhere in the vicinity of a river to permit of logs being brought to the locality in large numbers by water and also permit of the easy distribution of the shingles and battens after conversion. A plentiful and cheap supply of earth-oil would also be a desideratum. But I believe both these conditions are to be met with in this and adjoining divisions. The conversion of the shingles should include the use of both saw-pits and saw benches driven either by a steam or crude oil-engine. The latter for preference, as the earth-oil would be its fuel and no certificated hand would be required as with a steam boiler. The saw-pits would be used to break down the logs from the round to feed the saw benches. Combining hand-saws

and power benches is a much cheaper method than erecting large and expensive machinery in out-of-the-way places to deal directly with large logs in the round.

7. Under the above working conditions, I estimate a working capital as follows:—

	Rs.	a.	p.
Oil-engine of about 25 h.-p. with outfit,	4,500	0	0
Eight wooden saw benches with saws and pulleys	1,600	0	0
Shafting and brackets, etc.	700	0	0
Cost of working shed	1,000	0	0
Cost of setting up plant	1,000	0	0
Belting and small tools	500	0	0
Saw sharpening machine	200	0	0
Mill stores and spares	300	0	0
Total	9,800	0	0

say Rs. 10,000.

This machinery would easily produce 8,000 shingles and enough battens for same (1,072 r. ft.) per day.

For working expenses, duty on timber and the like, a further capital of Rs. 10,000 would be needed. Total capital Rs. 20,000.

8. Cost of producing shingles and battens.

	Rs.	a.	p.
Logging, dragging and rafting <i>didu</i> or <i>letpan</i> logs per ton	4	0	0
Duty per ton	1	8	0
Cost of converting one ton in the round into shingles and battens including all labour and depreciation on machinery,	7	8	0
Total	12	0	0

8. I did not give details of the third item of Rs. 7-8-0 as this would only encumber the note and add little to its value. I may only add that my calculations make it less than this amount and all the saw-mills along the Rangoon Prome Railway line undertake to saw up *pyinkado* timber at rupees ten per ton.

One ton *didu* will yield 1,200 shingles and 360 r. ft. of battens 2" x 1".

Rs. a. p.

The cost of the shingles may be taken as

Rs. 9 and of the battens as Rs. 3.

The cost of 1,000 shingles would thus be ... 7 8 0

and of 134 r. ft. of battens to suit ... 1 2 0

8 10 0

Earth-oil and labour for boiling and

bundling ... 3 8 0

Total cost ... 12 2 0

Now supposing the selling price of 1,000 shingles and 134 r. ft. of battens was fixed at Rs. 20 it would mean a profit of something over 60 per cent. And with shingles at this price, it would only cost Rs. 12 to roof 100 sq. ft., as compared with Rs. 15 for corrugated iron of the flimsiest quality and at the cheapest rate Burma has ever known.

9. The yearly earnings may be reckoned as follows:—

Daily outturn of shingles with necessary battens—Rs. 8,000.

Taking 280 working days for the year, the total output would be 2,240,000 shingles with battens.

Profit per 1,000 shingles = Rs. 7-14-0.

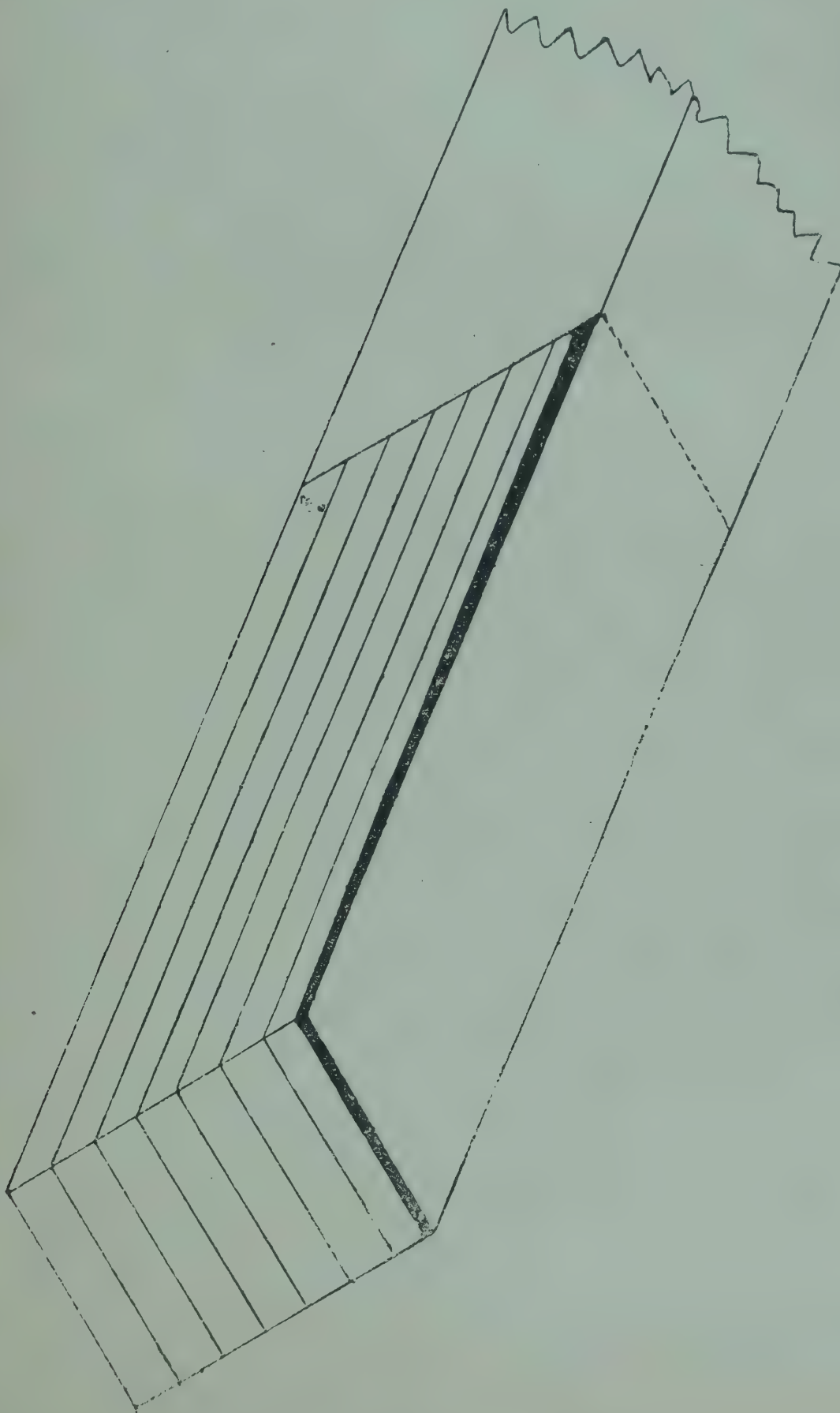
Profit on 2,240,000 „ = „ 17,640.

10. As to the ability of being able to dispose of 2½ million shingles it is only necessary to say that even a small house of about 24' x 24' takes about 8,000 shingles and it would take only 280 such houses to absorb the lot.

Shingles at the rate quoted would compete not only with cast iron but would tend to oust even the use of *dhani* palm leaves and *theke* grass, as in the long run the shingles would be cheaper, far less troublesome and more immune from fire.

11. The question of teak shingles is a very different proposition as they can only be profitably cut from refuse timber. Nevertheless

under a totally different system of working the possibilities are even greater than with junglewood shingles.



A LUCKY THIRD SHOT.

BY D. A. ALLAN, P.F.S.

The Bedin was a well-known elephant in the Thayetmyo district, and many attempts had been made to bag him : the last was by Captain A., about two years before I had the good fortune to get him. I was on my way up to the East Yoma reserve, to do some girdling, when I was informed by the local forester that Bedin was having a glorious time in the paddy fields of the Aingwun village, about five miles away, and that he had been in the vicinity for about a fortnight.

I started out after him early next morning and picked up his tracks about two hours after leaving camp. A track of about two hours followed and then we heard the welcome sound of bamboos being broken and knew we were up with him.

I left all the men I had along with me except one at the place where we first heard of the elephant and went on with one man.

I came on him at the edge of some bamboo forest close to an old 'taungya' overgrown with high Kaing grass, in which he had been feeding during the early part of the morning. As the sun warmed up, he got into the bamboo jungle.

The first I saw of my intended victim was his hind quarters and the ends of his tusks and then I knew why he was called Bedin. The left tusk had a very exaggerated upward curve which made the tip of it stick out much higher than the right tusk. (Be-din : left side raised).

Poor old Bedin, he was standing broadside on to me about 15 yards away, behind a large bamboo clump and every now and again I could see his trunk go up to break down a culm. The difficulty now was to get a shot before he winded me. I crept up another two or three paces and could get no closer, as there was a deep water-course between us and any attempt to get over this would have brought down an avalanche of stones and mud which would have given me away. The best I could do was to creep down the side of the hill along the edge of the water-course in the

direction in which he was facing, so as to get out of the line of the bamboo clump and then take a steady shot; I had partly accomplished my object and could just see a part of his head between the bamboos, when up went his trunk and I knew he had winded me, so had a shot at what I thought was the ear-hole.

The shot must have been deflected by a bamboo, for I made a clean miss and he turned and went off, like a steam engine, in the direction of the 'taungya' in which he had been feeding in the early part of the morning; but to do so he had to run uphill and diagonally across me. I gave him a second shot as he was crossing me which had no effect and a third just as he was about to top the hill. The last shot brought him rolling down hill almost on top of me, but he got up again and tried to make off; however, he was too far gone now to be able to get away and I eventually killed him about a hundred and fifty yards from where he was when I first saw him.

What a prize! the tusks when cut out were: Left side 6 ft. 6½ inches, right side 5 ft. 7 inches, girth of both 17 inches, weight 112 lbs.

In the hurry and excitement of starting in the morning, I forgot to take a tape with me so was unable to get his height, but from the measurements I made of the forefeet I made him out to be about 9 ft. 6 inches. Poor old elephant! He had had a rough time of it. I found two old wounds both healed up externally but on being cut open were full of matter. One was close to where the neck joins the body and the other at the back of one of the hind legs just above the foot, an apparent attempt to hamstring him. Needless to say, there was great jubilation among the villagers. They said once he got into a paddy field at night there was no getting him out of it. One sport said "he has been feeding on us for years and now we are going to feed on him."

EXPERIMENTAL SOWING AND PLANTING OF *CUPRESSUS GLABRA* IN GARHWAL (U. P.).

BY MATHURA PRASAD BHOLA, PROVINCIAL FOREST SERVICE.

A packet of seed of *Cupressus glabra*, a recently discovered Cypress, was received from the United States Department of Agriculture through the President, Forest Research Institute and College, Dehra Dun, in September 1916. The packet contained about 200 seeds. These were sown in the end of September in beds of the central nursery at Nagdeo near Pauri (Garhwal). The nursery is at an elevation of 5,700 ft. and is exposed fully to the effects of sun and rain, with north-eastern aspect, easy slope and shaly soil. The average rainfall at Nagdeo is 60 inches. The soil in the nursery beds was thoroughly worked and mixed with well-rotted humus before sowing the seed in lines 3 inches apart from each other. On account of scanty rainfall, the beds were watered by hand eight times in the month of October and germination took place early in November, only 16 per cent. of the seed germinating. There were no winter rains from November 1916 to the beginning of March 1917 and consequently hand watering of the seedlings was resorted to daily during this period. Thereafter there were almost continual rains and artificial watering was stopped.

The seedlings were inspected on 19th June 1917. There were 31 of them alive, all in healthy condition with an average height of 6 inches, the continual rains having evidently benefited them very much.

In the beginning of the following July, six of these plants were transferred into baskets and kept in the nursery for a month and were put out in August 1917 in an area near Nagdeo intended for reafforestation, enclosed by a walling and closed to grazing and fire. The situation of the area with regard to light, rain, aspect, soil, etc., is the same as described above for the central nursery. Pits spacious enough to accommodate the basketted plants were dug 5 ft. apart from each other and one plant was put in each, with surface soil, freed from stones, placed at the

bottom of the pit. Soil was firmly packed all round the basket in the pit, keeping the upper edge of the basket just below the surface of the ground with a little slope outward to drain off superfluous water. An inspection of the plants made on 15th February 1918 showed that five of them were flourishing and in very good condition and were on an average ten inches in height, while the sixth was sickly and there was very little hope of its surviving. No artificial watering and no tending of the plants was done, except that rank growth round the pits was cleared at the time of planting. The monsoon rains of 1917 were plentiful and the winter rains of 1917-18 were almost normal.

The remaining 25 seedlings were pricked out in the nursery beds in the month of July 1917 and placed 6 inches apart from each other. On the 15th February 1918, 13 plants were found to be in quite a healthy condition, their average height being 13 inches. Of the rest, eight were sickly with an average height of 6 inches with no promise of future and four were dead. The plants were watered by hand now and then. They will be put out in the next monsoon rains.

The experiment of sowing and planting this exotic species being of considerable botanical interest, further development of the plants will be observed and published in the *Indian Forester*.

IMPORTS OF JARRAH TIMBER INTO BRITISH INDIA DURING THE YEARS 1912-13 TO 1916-17.

We have received a letter from Millars' Timber and Trading Company, Limited, Bombay, pointing out what appears to be a mistake in the figure we quoted for the Imports of Jarrah Wood into India on page 21 of the *Indian Forester* for January 1918.

We are taking steps to have our figures verified and in the meantime we publish below the firm's letter and statement of imports :—

DEAR SIR,—In the *Indian Forester* of January, page 21, it is shown therein that Jarrah wood aggregating *24,477 tons was

* (The correct total is 24,615 tons and not 24,477 tons.)

imported into India during the period from 1912-13 to 1916-17. As this statement is not in accordance with facts, we beg to enclose herewith figures taken from the books of the Company, which tell a very different tale, and we feel sure you will take the earliest opportunity to place before your readers a correct statement which may be verified at any time.

A reference to our accompanying statement will show that Jarrah wood aggregating 111,786 tons was imported during the period from 1912 13 to 1916-17.

Since the outbreak of war imports have gone down, and now as no steamers are available imports for the time being are stopped.

Yours faithfully,

MILLARS' TIMBER AND TRADING CO., LTD.

Dated 14th February 1918.

Millars' Timber and Trading Co., Ltd. Jarrah Timber imported into India from 1912 to 1917.

	1912-13.		1913-14.		1914-15.		1915-16.		1916-17.	
	Quantity.		Quantity.		Quantity.		Quantity.		Quantity.	
	Tons.	C.ft. in. pts.	Tons.	C.ft. in. pts.	Tons.	C.ft. in. pts.	Tons.	C.ft. in. pts.	Tons.	C.ft. in. pts.
April—June	4,546	26 9 3	11,319	48 6 6	14,710	24 4 11	2,408	3 5 7		
July—September	8,634	4 6 2	4,504	13 5 9	6,945	28 1 4	3,577	24 11 10		Nil.
October—December	15,981	19 1 11	18,451	19 9 5	4,263	40 6 2	...	...		No steamers available.
January—March	3,540	12 2 4	9,112	16 11 2	3,791	30 2 2	...	...
Total	32,701	12 7 8	43,387	48 8 10	29,711	23 2 7	5,985	28 5 5		

SUMMARY.

	Tons	C ft. in. pts.
1912-13	...	32,701 12 7 8
1913-14	...	43,387 48 8 10
1914-15	...	29,711 23 2 7
1915-16	...	5,985 28 5 5
1916-17

Total ... 111,786 13 0 6

NOTE :—1 Ton = 50 cubic feet.

REVIEW.

Report of the Proceedings of the Second Entomological Meeting, held at Pusa on the 5th to 12th February 1917. Edited by T. Bainbrigge Fletcher, R.N., F.L.S., F.E.S., F.Z.S., Imperial Entomologist, pp. xii + 340 + Plates 34. (Calcutta : Superintendent, Government Printing, India, 1917. Price Rs. 3.)

This publication is a verbatim report of a conference of the entomological staff of the Agricultural Research Institute, Pusa, with delegates from the Agricultural Departments of the Provinces and Native States, and others interested in the progress of applied entomology in India. The insect pests of some two hundred agricultural staple crops, fruit trees, garden plants, etc., were considered crop by crop, during the course of the meeting, and a discussion was held on the status of each insect species as a pest in various localities, and on the possible measures for its control. The report is, therefore, practically an abstract of current knowledge of Indian crop pests. Thirty-four new coloured plates, recently added to the well-known Pusa life-history series, illustrate the report, and a valuable index of 27 pages completes the book.

In his opening address Mr. Fletcher emphasizes the importance of securing exact records of the occurrence of common insects, and we are in complete agreement with him when he states, "There is no insect, however common, of which we really know anything worth knowing, and it is by the accumulation of innumerable records of information, each doubtless small and unimportant, but each exact and complete in itself, that we may hope to attain to a more complete knowledge."

To many the serious record of an infinitude of small items of information may appear as a laborious cult of the useless ; but provided that the data recorded : (1) are published periodically in a collective form, (2) are facts and not assertions or conjectures, and (3) are observations incidental to greater work, we believe that such contributions to the lesser science establish their ultimate

justification. In the present report, perhaps, the insistence laid on the completeness of the verbatim record has led to the inclusion of several remarks distinctly bromide in tone, nevertheless, the compilation as a whole serves to emphasize that technical conferences of this type are productive of much new positive information, as well as indicative of the direction in which ignorance lies.

Mr. Fletcher is to be congratulated on the initiation of a system which provides, not only an exchange of ideas and information between isolated workers in applied entomology in this country, but a very vital stimulus. We note some omissions in the list of pests of tree crops and of garden plants, which would have been avoided if the Forest Department had been represented at the meeting as was originally proposed; forest officers, however, who have opportunity to consult this work, will find much in it of direct interest and utility.

One of the most interesting aspects of the report is obtained from the methods of control, which are recommended for individual pest species. For very evident reasons one does not expect to find measures involving the use of insecticides and spraying machinery adopted among Indian cultivators, except by the more progressive on a very small scale. Yet it is not without surprise that one observes the extreme simplicity,—at times approaching the ludicrous,—of the control measures which are recommended and which have been found successful. In general, they are remedial and resolve into the direct collection and destruction of the injurious caterpillars, beetles, bugs, grasshoppers, etc., on or near the plants they have damaged. The cultivator is recommended to employ nets (hand nets and large bag nets requiring four men to work them), vessels containing oil and water-oiled ropes, etc., and in specific instances to destroy affected plants. Preventive, cultural, and allied measures less transparently obvious to the cultivator, do not appear to be generally utilized except in the case of some of the pests of rice, other cereals, sugar-cane and cotton.

It is interesting to find that the general principles of agricultural crop pest control are in India so fundamentally opposed to

those of forest pest control, and that one can extract little that is suggestive or capable of parallelism. Even in the case of those types of insect damage which are common to both classes of crops, *e.g.*, injury by root-eating termites, cockchafer grubs, seed-weevils, stem-borers, the Agricultural Department can offer only limited assistance.

On the other hand, it must be admitted,—if we may judge from the present attitude of the Forest Department towards insect pest control,—it is more probable that agricultural methods of control will be brought into force in nurseries and plantations before silvicultural methods are introduced into forests.

C. F. C. B.

EXTRACTS.

NATURAL REGENERATION OF CONIFERS IN THE PACIFIC COAST FORESTS OF THE UNITED STATES.

In a study of the natural regeneration of the Douglas fir and other conifers in the Pacific coast forests of the United States, published in the *Journal of Agricultural Research*, Vol. XI, pp. 1—26 (October 1917), J. V. Hofmann shows that when a large area is either burnt or cut away the complete restocking which usually takes place does not result from the seeds that are scattered by surviving trees on the area or in its vicinity. The distance from the parent tree to which seed is carried by the wind is very small, 150 to 300 ft. Consequently, if only wind-dispersed seed germinated, the regeneration of a large area would not be completed until after the growth of several generations of trees. The reproduction is never a gradual creeping out from surrounding bodies of green trees, but is a sudden taking possession of the whole area by a dense growth of seedlings. The regeneration is really effected by the seed which is stored in the ground amidst the litter and humus, which are not destroyed in the swift passage of the ordinary forest fire. The litter is found on examination to

contain a large number of germinable seed. The ordinary form of succession is the replacement of the forest almost immediately by the same species as composed the original stand, and usually in the same proportions. This paper is well illustrated with diagrams and photographs. One plate is a view of the reproduction on the Yacolt "Burn" of 1902 in the Columbia National Forest. The extent devastated by fire is 604,000 acres. No green trees are visible, yet there are seedlings growing among the snags over the whole area.—[*Nature*.]

[The above is equally true under certain Indian conditions. A big fire occurred in 1903 on the Rimbick Spur (Darjeeling) between 7,500 and 10,000 ft. altitude. The forest consisted of Oaks, Chestnuts, Magnolias, Hemlock spruce, etc., and in the upper portion Silver Fir.

There was a dense undergrowth of Maling bamboos (*Arundinaria racemosa*). The forest happened to be in an unusually dry state at the time of the fire, so much so that in the passage of the fire the green bamboos dried and burnt giving rise to a fire of extraordinary intensity resulting in the total destruction of the forest.

This forest had never been burnt before in the memory of man, and trees of 12 to 18 ft. in girth were not uncommon; as a result of the fire, however, not a tree survived.

The ground resembled a charcoal kiln and it seemed almost impossible that seeds even buried in the soil, could have survived. However, to the great surprise of the writer, two months later, at the burst of the monsoon, the seedlings appeared everywhere especially *Magnolia Campbellii*.

It would be interesting to learn the condition of the crop at present.—HON. ED.]

WOOD DISTILLATION.

The distillation of wood from our Indian forests is an industry that must one day be taken up seriously, it being clear from a note on the subject in the *Bulletin of the Imperial Institute* that it will bring in a good return. The demand for oils and tar in this country is steadily increasing, and one day the demand for alcohol will also become insistent. If wood distillation in India itself can give us what creosote, tar and alcohol we need for use in our oil engines, for the preservation of our timber and for use on our roads, the sooner we take to manufacturing them on the spot the better. It is unlikely that the price of any of these when imported will ever fall much, and as they now stand India is unable to

compete with other countries in such industries as depend largely on these three products of wood distillation. Besides these there are other by-products such as acetate of lime, acetic acid, acetone and charcoal, the first three always in great demand and in greater demand than ever at the present time for munition purposes. The hard woods and the soft woods give differing results after distillation. The first give low yields of black, viscous, ill-smelling tar but high yields of acetic acid and wood spirit (methyl alcohol). Two typical woods may be taken for example, the one hard the other soft, and their distillation products compared.

	Oak Wood. Pine Wood.	
	Per cent.	Per cent.
Acetic acid	4.4	2.2
Equivalent to acetate of lime ...	5.8	2.9
Methyl alcohol	1.1	0.6
Tar, separated	6.4	12.9
Charcoal	25	29

The crude acid when redistilled and neutralized with lime produces grey acetate of lime, the value of which is at present £36 per ton, whereas before the war it was only £8 per ton. There is a large demand for it for the extraction of acetone. Some of it is manufactured in Ceylon and the Imperial Institute, on behalf of the Home Government, is enquiring if any of it is available for export. Acetone is required in large quantities for the manufacture of propellant explosives. Acetic acid is produced in large quantities in Ceylon and used in the preparation of rubber. Cocoanut shells when distilled give a good yield of acetic acid and produce also creosote required for the preparation of smoked rubber. There is also a timber known as Vera wood growing in the dry zone of Ceylon from which is distilled crude acetic acid liquor, charcoal and tar, in fair quantities. By redistilling the crude liquor, after the addition of fresh charcoal, a pale yellow, clear solution of acetic acid is produced. Methyl alcohol is the chief constituent of the commercial product known as wood alcohol or wood spirit, which includes some acetone, esters and other products. The value of this product in July 1914 was

2s. 7d. per gallon but at the close of 1916 had risen to 5s. 6d. It has already been stated that the distillation products of hard woods and of soft woods differ somewhat. In considering tar it must be noted that hard wood tars cannot be used for treating ropes and twine. Soft wood tars, on the contrary, such as those obtained from pines and coming on the market under the name of Baltic and Stockholm tars, are the ones suited for this purpose. There is, in fact, not much scope for the use of hard wood tars except in the way of fuel. Noting that black wattle wood and olive wood experimented on at the Imperial Institute were obtained from the East Africa Protectorate, the Institute give us the following table of distillation products:—

	Acetate of Lime.	Wood Spirit.	Tar.	Char- coal.
<i>Oak Wood—</i>				
Yield per ton	112 lbs. ...	3½ gals. ...	100 lbs. ...	580 lbs.
Value of yield, June 1914 ...	...	8s. 4½d. ...	{ 1s. 9d. 2s. 3d. }	14s. 10d.
" " Dec. 1916 ...	£1 16s. ...	17s. 10½d.	...	...
<i>Black Wattle Wood—</i>				
Yield per ton	139 lbs. ...	3·7 gals. ...	134 lbs.	605 lbs.
Value of yield, June 1914 ...	9s. 11d. ...	9s. 6¾d. ...	{ 2s. 4¾d. 3s. }	15s. 6½d.
" " Dec. 1916 ...	£2 4s 10d.	£1 0s. 4d.	...	...
<i>Olive Wood—</i>				
Yield per ton	90 lbs. ...	5·0 gals. ...	166 lbs.	650 lbs.
Value of yield, June 1914 ...	6s. 5d. ...	12s. 9d. ...	{ 2s. 11½d. 3s. 8½d. }	16s. 8d.
" " Dec. 1916 ...	£1 8s. 1d.	£1 7s. 6d.	...	...

It will be seen that, taking the prices obtainable in June 1914, which may be regarded as normal, both wattle wood and olive wood show a slight advantage over oak wood, and should, therefore, be at least as profitable to distil.

Practically the whole of the imports of the products of wood distillation are retained in the United Kingdom ; further, the only country of the Empire which supplies the United Kingdom with

any of these products is Canada. This is extremely unsatisfactory both for the United Kingdom and for India. We in India cannot get them even from Home and must depend on foreign countries for what we need when we have in more than abundance the materials in our forests that could supply both Indian and Home needs. If and when the Forest Department wakes up to its possibilities let this matter of wood distillation, therefore, not be forgotten.—[*Indian Engineering.*]

[The Forest Department is fully alive to the possibilities of wood distillation.

Just at present, with the price for acetate of lime unduly inflated by war conditions, wood distillation would probably pay almost anywhere, but unfortunately the necessary plant is not now procurable. When normal conditions reassert themselves the conditions necessary for success are that each and all of the products of distillation should find a ready sale in the country of production. It is in this respect that Indian forests are at present at a disadvantage as compared with those in America or in Europe, where the proximity of big industrial and chemical concerns ensures a demand for all the products of distillation—HON ED.]

NOTES ON DRY ROT.

India is a country in which timber is very susceptible to dry rot while few realize the extremely "epidemic" character of the disease. A paper by Mr. E. J. Goodacre, Assistant Borough Surveyor, Shrewsbury, brings together much useful information regarding the character of the disease and how it should be prevented, but even he admits that much remains to be studied on the subject. That it is virulent, spreading, and hard to eradicate is certain, its very insidiousness making it difficult to detect; it is also certain that the destruction and loss caused by it is enormous because of its insidiousness. So far three forms of the disease have been recognized—(1) *Merulius lacrymans*, (2) *Coniophora cerebella*, (3) *Polyporus vaporarius*. The first has been so named because of its dark colouration accompanied by the collection of fluid globules; it prevails in moderate climates and where subsoils of a clayey nature exist. It does not need moisture for its support so that once established it can develop on and destroy the very driest timbers. In appearance it takes the form

of dark brown rusty patches with white margins; these are large and undulating and contain the spores, when they face upwards the spores become infertile, when downwards the spores are fertile and of great vitality, living for many months together when kept dry. From the patches above noted there spread out what are known as hyphæ which also produce spores and spread the disease; they weave themselves into strands or cushions known as the mycelium, requiring no moisture for their sustenance, so that they can extend themselves over brickwork and even glass to attack other timber a long way off. Of the three this type of dry rot is the most malignant. *Coniophora cerebella* resembles *merulius lacrymans* in appearance but requires moisture for its subsistence, for which reason it can be more readily dealt with; its mycelium consists of slender black threads in great profusion. *Polyporus vaporarius*, or red rot, has white squares, its hyphæ become very tough when old instead of brittle; in deal it is seen in red decayed patches, hence its name.

All spores being of microscopic size can float away long distances in the air and cause infection far and wide provided they meet with congenial germinating spots, which are chiefly moisture and moderate temperature, *coniophora* requires a good deal of moisture, and hence germinates in very damp situations. The other two, *merulius* in particular, when once established, can grow on the driest wood, depending on their own power for the production of moisture. *Merulius* also, though it thrives in a moderate temperature, is killed by one of 40° C. So that infected wood, if heated above 40° C., can be sterilized, and that steaming has a curative effect. Dry rot generally progresses much faster in summer than in winter in an ordinary building which is heated and thus has its air made relatively dry during the winter months. When timber is effected it should be tested by boring holes at intervals; if there is dry rot the borings will show a brown powder. The dull sound made by a hammer is also a means of detection and often the distinctive smell of the disease. Infection commonly takes place in the timber yard itself and therefore it is recommended that all such yards be paved with tar-macadam. Stacked timber

should be seasoned, be kept dry and well ventilated and even, if possible, desiccated or stoved to a temperature of 50° to 60° C. During construction timber should be protected against wet and in construction secured by good ventilation; floor joists, especially ground floor joists, should be creosoted; all rejectable earth should be removed from under floors; and the building site should be covered with at least 4 inches of cement concrete, asphalted on the upper surface or with tar-macadam. The method is of course expensive but necessary where conditions point to the practical certainty of destruction by dry rot. Under-ventilation should be provided by fixing fresh air inlets on all sides with an extraction flue taken up the chimney breast alongside the smoke flues. The ends of all joists should be fixed in such a manner that there is a passage of air all round the end of the joist as far as possible. Shavings left under the floor boards often originated dry rot; in cases where boards or wood blocks are fixed directly on the concrete, they should be bedded on some bitumastic compound. Skirtings and other wall mouldings should be fixed after the walls are dry and should preferably have a backing of cement rendering, damp-proof courses are always necessary, they may be of lead, asphalt, bitumastic compounds on fabric, or slates in cement. Hollow walls too are a good precaution against dry rot.

When dry rot has been established the infected wood should be oiled to keep down the spores, then be removed and burned, the tools used for the purpose should be sterilized, the brickwork and stonework should be sterilized by a blast flame, and the woodwork should be dried and treated with a wash of dilute formalin or carbolic acid. Hot limewash is very useful for a mild attack, and, in fact, most antiseptics are more or less effective. It must, however, be always remembered that the only real safety lies in prevention and that crores may or may not reach all parts of an infected structure.—[*Indian Engineering*.]

[So far as we are aware no dry rot fungus has yet been definitely identified in India.—HON. ED.]

MATCH-MAKING IN INDIA.

The annual report of the Director of Industries for the United Provinces states that despite valiant attempts to keep going on, the Bareilly Match Factory have been compelled to close down their works at the end of May 1917. The difficulties with regard to wood were successfully overcome with the aid of Government, but it has been found impossible to compete with imports owing to the prohibitive prices which have had to be paid for chemicals, while it has also been found impossible to get supplies of the special paper which is used for binding and covering the boxes. The requisite chemicals are not yet made in India, nor has it been found practicable so far to secure a satisfactory paper in India. Whether it will be found possible to recommence operations after the war cannot at present be determined, but it appears to be clear that match-making industry will never be established upon a sound basis in India until a larger proportion of the requisites of manufacture are produced locally, or some special treatment is accorded to this industry which will serve to compensate for the heavy costs of chemicals when imported from abroad. Under ordinary conditions sea freight from the countries supplying India with matches are less than the railway freight for an average inland lead in India, so that the Indian manufacturer derives little advantage from his location. Nor is he much better off than his foreign competitor in the matter of Customs duty when he pays the full tariff duty on all the ingredients and paper which he imports because local supplies are not available. The total imports of matches for the year ended March 31st, 1917, were valued at Rs. 1,15,69,771, the average price being a fraction over one rupee per gross.—[*The Oil and Colour Trades Journal.*]

INDIAN FORESTER

JULY, 1918.

SUGGESTIONS TO INTRODUCE SPECIAL WORKING PLANS
FOR THE EXPLOITATION OF *BASSIA LATIFOLIA*, ROXB.,
AND *BASSIA LONGIFOLIA* IN INDIA, AND TO RESTRICT
THE MANUFACTURE OF THEIR RAW PRODUCTS
WITHIN THE EMPIRE.

BY G. M. RYAN, I.F.S. (RETIRED).

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C/O MESSRS. H. S. KING & CO.,
9, PALL MALL,
LONDON, S.W.

FROM

G. M. RYAN, ESQ.,
IMPERIAL FOREST SERVICE (RTD.),

TO

THE SECRETARY OF STATE FOR INDIA.

London, 29th November 1917.

SIR,

I have the honour to submit, for the favour of perusal, the accompanying copy of the Journal of the Royal Society of Arts of the 25th May 1917, containing (a) a paper read at a Meeting of the Society on the 19th April at which I was invited to be present, on the Recent Industrial and Economic Development of Indian Forest Products, by Mr. R. S. Pearson, Forest Economist, at the Forest Research Institute, Dehra Dun, and (b) subsequent proceedings of the Society. (Appendix I.)

In submitting these printed papers, I take the opportunity of making the following remarks about *Bassia latifolia*, Roxb., and *Bassia longifolia*, and the liberty of offering some suggestions as to the necessity which seems to exist of drawing up special Working Plans for their preservation and extension in India, and of attempting to restrict the manufacture of their raw products within the Empire which, I trust, may meet with favourable consideration.

I. PRELIMINARY REMARKS.

Bassia latifolia, commonly known as Mhoura in Western India and Mahua in other parts, has attracted my notice for a considerable period during my service as being a tree of great commercial importance and unique interest in India, and I thought that perhaps, by this time, something might have been attempted in the way of securing its future regeneration in Bombay at least, if not in other parts of India—seeing that its economic products, especially seeds, have been such an important article of export from that country for some years past.

After hearing Mr. Pearson's interesting paper read, however, I was somewhat disappointed to find that nothing apparently has been done yet in this direction.

In the discussion which followed on the reading of the paper in which I was invited to take part, what I actually said was somewhat as follows :—

“ It appears from Mr. Pearson's excellent paper that a great deal is being attempted by the Forest Department towards the economic development of the forests in India, by endeavouring to find new products and by establishing new industries there, but that no mention was made in it of any attempts to organize and develop the collection of those forest products which have already a commercial footing and some of which are largely exported from India, *viz.*, Mhoura, Myrabolans and Bamboos.”

From want of space, my detailed observations on these points were not reproduced in the proceedings of the Royal Society of Arts. It will be seen, however, from a perusal of so much as has been published, that reference was made to the absence of regeneration of Mhoura and that probable reasons were assigned for such want; and it is proposed now to make this the basis of my present representations. Without systematic arrangements being made for the regeneration of a species in a forest under exploitation, it is obvious that the future of that species must be seriously jeopardized. This fact is so patent that it would appear superfluous to mention it. The principle is recognized and given practical effect to in organizing the output of major forest products such as timber and firewood and some minor products such as rubber and lac—so why not in the case of Mhoura?

The reason may be, as alleged in my remarks at the Society of Arts meeting, namely, that the presence of the Mhoura tree in forest is objected to because of its being a fertile cause of forest fires and also a source of intoxicating liquor, which objections I will now briefly enter into.

2. DANGER OF FOREST FIRES FROM MHOURA TREES.

Adequately to understand how it comes about that Mhoura trees are a source of forest fires, it is necessary to explain

first this relation between cause and effect. In the month of March, which is the beginning of the hot season in the Mhoura region, the tree comes into flower. After pollination has been effected the corollas get disengaged from the calyx, and drop one by one on the ground during the night and cool hours of the morning and evening. In the forests, grass and dry leaves are to be found in quantity beneath the Mhoura trees—and the corollas falling in amongst the rubbish are difficult to gather. In order, therefore, to facilitate their collection the ground underneath the trees is usually cleared of all grass, etc., by burning previous to the fall of the corollas. It can easily be imagined, under the circumstances, that in wind-swept forests, where the grass is as dry as tinder and abundant, how a fire once started beneath a tree must spread in a forest, unless special precautions are taken. Great damage, no doubt, results at times to a forest from negligence of this kind. Measures, however, are adopted to check such carelessness and to control fires in a forest if they occur. In addition to a permanent staff of forest guards, special gangs of men known as fire-guards are annually employed to patrol the forests in the dangerous season and to suppress them. Their duty is not only to patrol and extinguish fires but to demarcate the forests into restricted areas by cleared rides 50 to 100 feet wide. Special legislation is in force, also requiring persons to clear minor rides round each Mhoura tree or group of such trees, to prevent the spread of a fire into the forest if one is started by anyone under the tree. Measures to provide for almost every conceivable contingency are, in fact, in force to securely protect the forests from burning. Fires occur nevertheless; but it is well known that such accidental fires are not peculiar to the Mhoura tracts: they occur all over India in State and private forests where rights of user exist.

One cannot help but sympathize with some Forest Officers, however, who being anxious about the satisfactory regeneration of their forests advocate the removal of Mhoura trees from them in order to reduce the risk of fires from the above cause.

But, surely, this negative attitude is not the proper one to adopt in connection with a tree which, as I propose to show in this

report, is probably more valuable to the State, both financially and in various other respects, than any in India.

The proper course, under the circumstances, for the Forest Department is to grapple with the evil, and try and overcome it by efficient administrative methods which is feasible, I submit, with the means the State provides for the purpose.

3. COROLLAS OF MHOURA—A SOURCE OF INTOXICATING LIQUOR.

It is unnecessary for me to enter at any length into this subject, for the utility of the dried corollas of the Mhoura flower for the purpose of manufacturing country liquor is well known. In the Bombay Presidency this manufacture is State-controlled, and the right to purchase the corollas in the forests and to manufacture the liquor for public sale yields a large annual revenue to the State. In consequence, however, of the evil resulting from Mhoura liquor drinking—increase of crime, for instance in Guzerat, in a favourable flowering season is attributed to the excessive drinking of the Mhoura spirit—many Revenue Officers dislike the Mhoura tree and object to any extension of its cultivation.

They are, no doubt, perfectly justified in their attitude in this respect, but it is a question for decision whether the evils resulting from the abuse of Mhoura liquor drinking outweigh, in importance, the great utility of the corollas and seeds as articles of food to the people.

I propose briefly to touch on these points now, and to explain that recently a new use has been found for the corollas which so enhances their economic value as to outweigh any objections arising from their being a source of intoxicating liquor.

One might as well object, it appears to me under all the circumstances of the case, to the cultivation of the potato because it is a source of alcohol, as object to Mhoura. However, this is a question for the consideration and decision of Government, and I respectfully hope that it will be settled once and for all.

4. ECONOMIC USES OF THE COROLLAS.

About 33 years ago, it was estimated in the Central Provinces (vide *Dictionary of Economic Products*, Vol. I, pp. 410-411) that

over one million people used the corollas of the Mhoura as a regular article of food, each person consuming about 80 lbs. per annum, an amount that would set free about 120 lbs. of grain or 30 per cent. of the food necessities of the people. This, at the lowest estimate, comes to one-quarter of a million pound sterling which the value of the tree represents in the Central Provinces alone.

In the Bombay Presidency, the dried corollas of the Mhoura have a similar high economic use. They always have been held in high estimation as an article of diet amongst the Bhils and other forest tribes, and continue to be used for domestic consumption on a large scale by them and others. Almost every district officer, in fact, knows this, and it is well understood too what a stand-by these corollas have been in seasons of scarcity or famine. In parts of Guzerat and the Satpura Hills in Khandesh, the existence of a good crop of Mhoura flowers, as they are popularly called, has often staved off the necessity of Government relief measures in a famine year. But it is perhaps unnecessary to labour the point of the value of the corollas as an article of diet—the fact is too well known.

5. NEW USE OF COROLLAS.

Since the outbreak of war, however, a comparatively recent chemical analysis of the corollas has proved them to be a source of acetone, which is the chief ingredient in the manufacture of cordite. This discovery, it is thought, lends not only to remove at once any doubt which may have previously existed as to the desirability of encouraging the growth of *Bassia latifolia* in forests and waste lands, but makes it more incumbent on the part of the State to foster and extend its production.

It is well known that acetone can be obtained by the destructive distillation of wood, but 100 tons of wood yield, at best, only one ton of acetone.

Fresh Mhoura corollas, on the other hand, it is alleged, will produce about one-tenth their weight of acetone, or nearly ten times as much as is obtainable from wood; and they can be had in

comparative abundance. The great value of the corollas, therefore, can be judged at a glance, if this information is correct, independently of their other economic qualities.

With acetone at £180 a ton, well might the extension and cultivation of the Mhouira tree in forests and waste lands be taken in hand for almost that purpose alone.

In normal times, perhaps not a very great quantity of acetone—say about 500 tons annually may be required for military needs in India: but the British Empire's requirements in this direction must not be lost sight of. It will be possible, it is understood, to export the surplus stocks of dried corollas from India all over the Empire, with considerable economy and profit, for the purpose of the manufacture of acetone. However, apart from acetone, there are other avenues of possible use for the corollas such as sugar and motor spirit as Mr. Wakefield has explained in his note.

Some years ago, a chemical analysis of the dried corollas demonstrated the existence in them of 49·8 per cent. invert and 13 per cent. cane sugar (*vide* Annual Report of the Board of Scientific Advice for 1909-10, p. 29). At a time when the quantity of sugar available within the Empire is so limited, the successful preparation of it from the corollas of *Bassia latifolia*, if possible, would be a great advantage. This, it is believed, is already engaging the attention of the Government of India.

6. MHOURA SEEDS—A VALUABLE COMMERCIAL PRODUCT.

Apart from the economic uses of the corollas, as above explained, the cotyledons too, or seeds as they are popularly termed, are of considerable commercial value, mainly for export to Europe. This matter, however, need not be entered into at any length here for the commercial importance of the seeds was fully ventilated in a paper I wrote on the subject in 1904, which has been favourably commented on by Sir George Watt in his work "Commercial Products of India" (p. 120), and since 1907 the Bombay Government have been exploiting the seeds from some of their forests and waste lands at considerable profit (*vide* correspondence

commencing with my No. 267 of the 6th October 1903 when I was in charge of the Central Thana Forest Division printed as an accompaniment to Government Resolution No. 2194 of the 19th March 1904 and ending with Government Resolution No. 1077 of the 3rd September 1906 and subsequent Resolutions). Suffice it to say here that the exports of Mhoura seeds from India from 1907 up to the outbreak of the war in 1914 were as follows:—

			Calcutta.	Bombay.
			Tons.	Tons.
1907	...	...	1,900	29,453
1908	...	...	259	25,988
1909	...	...	4,545	31,275
1910	...	...	4,295	18,952
1911	...	...	4,077	35,818
1912	...	...	269	13,861
1913	...	...	567	31,034
1914	...	...	357	7,771
			<hr/>	<hr/>
			16,269	194,152
				16,269
				<hr/>
				8) 210,421
				<hr/>
			Average	26,302

The above figures have been supplied through the courtesy of Messrs. Ralli Bros., London, who are the largest exporters of Mhoura seeds in India. They estimate the value of the Mhoura exports at £12 per ton, according to which rate the annual value of the total exports for the past eight years would be £315,630.

From the statement attached (Appendix II) it will be understood what the probable sources of these exports are, as well as their estimated value to each Presidency or Province or Native States in British India. The estimates of Native States are given in lump. In the Bombay Presidency, it will be seen that if all the State areas where Mhoura is now found were exploited officially, a net income of about Rs. 1,20,000 might be expected annually therefrom. Similarly, an income of about Rs. 10,000 annually is

estimated from Madras. It is difficult to estimate the returns from other Provinces because of the absence of details affecting Mhaura in all their Annual Reports. I have entered, to the best of my knowledge, a total sum from such places which would be realizable, if all the areas in them were exploited under State control, *viz.*, Rs. 1,05,000. Speaking generally, Mhaura is found in comparative abundance in the Central Provinces and Chota Nagpur but less so in the United Provinces and Bihar and Orissa.

The total revenue from Native States is estimated at Rs. 1,80,000. The largest sources of supply would probably be from Hyderabad (Nizam's Dominions) and Indore (Holkar's Dominions). In Baroda, efforts are being made, I understand from Mr. R. H. Madan, the energetic Conservator of Forests, to extend the area under Mhaura in forests, especially in the Kathiawar region and elsewhere.

7. SUGGESTION TO RESTRICT THE MANUFACTURE OF THE RAW PRODUCTS OF MHAURA WITHIN THE EMPIRE.

Since the outbreak of the war, the exports of seeds from India have, owing to the want, it is understood, of transport to Europe, diminished considerably. The seeds were mainly utilized on the Continent, chiefly in Germany and Belgium, before the war for the manufacture of margarine and soap, etc. Rapeseed and linseed have now taken its place, it is understood, especially for margarine manufacture because of their smaller bulk and consequent cheaper freight, and are shipped to Holland. The rapeseed and linseed are admitted into Holland now apparently under license, and a proportionate quantity of margarine is exported to England. It is hoped that, after the war, this expensive and unsatisfactory state of things will not be allowed to continue, but that the production and handling of this, as well as other products of the tree, will be so organized as to restrict their manufacture within the Empire. There seems no reason now why India should not undertake this task or failing that England, and I have already broached this subject to the chief partner, in London, of one of the leading Indian firms who is considering the proposal favourably.

8. NECESSITY OF ORGANIZED MEASURES FOR THE REGENERATION, ETC., OF MHOURA.

I can scarcely believe that the State wishes this valuable commercial article and the other important products of the tree to become gradually extinct as they assuredly will, unless special organized measures for the natural and artificial regeneration of the tree and control of seed exploitation are adopted.

It must be remembered that many commercial firms are engaged in Bombay and Calcutta, in England and on the Continent of Europe, in trading in Mhoura seeds, and that the demand for the seeds leads to the regular employment of a large number of people in India, at a slack season of the year (so far as the demand for labour is concerned), who earn a good living by collecting them for the mercantile community. Is it not the duty, under the circumstances, of the State, which owns a large proportion of the trees from which these seeds are gathered, to make systematic attempts to keep the trade in being and urge others also to do the same? At present nothing apparently like this is being done, or even proposed, and unless the Mhoura areas all over India are brought under scientific organized plans the trade in Mhoura seeds and the fate of the other highly valuable economic products of the tree are doomed.

It is necessary to emphasize this and to suggest that not only should some organized attempts be made promptly but that the measures should include increased production of the tree wherever it is found.

In some localities, such as East Khandesh, Mhoura has already commenced to disappear, and in the Panch Mahals where thousands of trees died, as stated by Mr. Pearson during the prolonged drought of 1899—01 (vide *Indian Forester*, p. 124, Vol. XXX, 1904), the number of trees now living is considerably less than in former times.

In the Konkan, some natural regeneration of Mhoura is observable, it is true, due chiefly to the action of flying-foxes and crows which eat the fruit and distribute the seeds, but such regeneration is negligible for all practical purposes.

But it can be understood that natural regeneration, generally speaking, must be practically *nil* from the fact of no seeds being left on the ground, owing to such large collections, mainly for export to Europe.

Nature obviously intended that a certain proportion, at any rate, of these seeds should be left on the ground to promote reproduction of the trees. It must not be forgotten also that the annual removal of the corollas, by a clean sweep from the ground as it were, by the people for their own and trade purposes must, to a very great extent, impoverish the soil, and thereby add to the difficulties of natural regeneration of Mhoura, as well as probably curtail the life of the tree. It is more than probable that the sugar in the corollas, if left on the ground, would ferment, and that the products of fermentation would be absorbed by the soil and become available for the roots of the tree. Wild animals too, such as bears, hyænas, jackals and deer especially being attracted by the abundance of food would collect under or near the trees in the Mhoura region and by their constant droppings assist in fertilizing the soil.

In the Dangs (Surat District) monkeys are known to collect on the trees to eat the fruit and seeds of the Mhoura in such large numbers as to considerably reduce the supply of seeds available for export.

Is the present unsatisfactory state of things with regard to the regeneration of Mhoura to be allowed to continue? In the words of an able Forest Officer of the Central Provinces, Mr. Fernandez, when writing many years ago about the future of Mhoura, "Is this goodly endowment of bountiful nature, this inheritance, to be wrecked or impaired?"

It is the duty of the Forest Department, of all others, I think, to prevent this: to see that the present generation of inhabitants does not endanger the wants of future generations by attacking the capital when it is only entitled to the annual yield. This principle is recognized and followed, as already remarked in regard to the exploitation of timber, firewood and rubber and probably lac in some places, but not in all as far as I am aware:

at any rate, not in the Bombay Presidency ; but, in regard to Mhoura, it seems to be entirely neglected. It is especially necessary, however, in its case. As a purely commercial undertaking, it would pay to devote time and energy to the growth of Mhoura because the annual financial yield from the disposal of its minor products alone would, it is thought, exceed the revenue derivable from timber and firewood if grown on the same area.

It might be objected that this is a fallacious argument because a timber and fuel crop could be grown more closely on the land and that, therefore, the annual financial yield of such crop would be in excess of that realized from the minor products of, say, 15 or 20 Mhoura trees which might instead be the number grown on the same area ; but a close investigation into the subject will, it is thought, dispel this contention.

Under an efficient organized scheme 15 to 20 large Mhoura trees could be grown per acre—with junglewood species intervening—whereas, omitting Mhoura from the area altogether, a crop mainly of junglewood species, yielding only material fit for fuel, would be obtainable. In the Panch Mahals and parts of Khandesh, teak is an associate of the Mhoura, it is true, but it is mainly of the size of poles and is usually dominated by the former. The growth of the two in the same area, therefore, would not be irreconcilable.

9. MHOURA AS A VALUABLE TREE FOR AFFORESTATION PURPOSES IN THE DRY ZONE.

It would be lamentable, from an œcological point of view, to allow Mhoura to disappear from, say, the Deccan and Central India and parts of Rajputana-Guzerat, because it is specially adapted by nature with qualities to thrive in such localities which are subjected to long periods of drought, and scanty and capricious rainfall. In a word, it might be characterized as a xerophytic type of vegetation, that is a tree supplied by nature with special adaptations for obstructing desiccation. It is, by habit, a deep-rooted species but can adapt itself to shallow soils, as in the Satpura Hills, by the formation of buttressed roots :

possesses a thick bark, and below the bark abundant latex which is a provision of nature for mitigating the effects of radiant heat. The leaves are coriaceous and the wood dense and hard. There are no other species in the same zone, except Salai (*Boswellia serrata*) and some Apocynaceous and Asclepiadaceous shrubs that possess such xerophytic characters. Apart, therefore, from its economic and commercial aspects it is of supreme importance to encourage its growth for climatological reasons, especially in the hilly tracts of the dry zone. In the areas in Guzerat where trees in thousands are said by Mr. Pearson to have died from severe drought, Mhaura probably was an introduced or cultivated tree; but in Khandesh where it is indigenous long continued drought has not had the same effect.

10. SUGGESTION AS TO THE BEST FORM OF WORKING PLAN FOR MHAURA.

It is not possible to suggest a uniform Working Plan for Mhaura as localities differ so much all over India and conditions are so variable but, speaking generally, a plan based on the number of trees to be exploited annually would probably meet the requirements of the case better than any other founded on volume or area.

If my own experience is of any assistance in the drawing up of such a plan, I am happy to give it for what it is worth, trusting it may be of some service because the problem of dealing with *Bassia latifolia* is complicated by reasons of trees having to be dealt with not only in forests but waste lands, and it may, therefore, at first sight, seem unworkable. Moreover, any plan based on the enumeration of trees might be considered too laborious and expensive a task for the Working Plans staff to undertake.

When holding charge of the North and Central Thana Forest Divisions of the Northern Circle, Bombay, in 1904-05, I was confronted by a very awkward problem owing to the effects of a severe cyclonic storm in those Divisions. Thousands of sound healthy teak and other trees in forest and teak in waste and

occupancy lands, were blown down ; but the bulk of the damage resulted to the teak and over one million of such trees came to grief. A sanctioned Working Plan already existed for the forest areas where this storm occurred. Were the prescriptions of this plan in these areas to be carried out in spite of the disaster, and the uprooted trees in the different blocks dealt with accordingly, or was the plan to be entirely suspended and a new scheme drawn up for the damaged trees only ? The problem was solved by, first, a suspension of the existing Working Plan with the consent of Government.

An entirely new rough plan was drawn up, instead, with the approval and co-operation of the Collector and Government, under which several working circles were formed and the unit of area of exploitation was taken as the *Forest Round*, which of course included tree-covered areas in forest and non-forest villages. The fallen teak trees only in the villages of this Round were enumerated by the local guards and revenue subordinates—and when the lists were prepared, a fixed number of the trees was sold by tender to the highest bidder. In this way, it took about five or six years to enumerate and dispose of all the uprooted teak trees, but the counting was gradually and successfully carried out ; and my contention is that, in the case of a valuable tree like the Mhoura, a similar enumeration, with the co-operation of the Collectors in each Division, according to two age-classes, *i.e.*, non-bearing and bearing trees, might be conducted gradually, and without the expense of any special enumerating staff.

Such enumeration would probably be extended over a couple of seasons only. The above is merely an outline—intended to help the officers responsible for devising a practical scheme for exploiting the tree. A full-grown Mhoura is, in my estimation, more intrinsically valuable to the State than any other forest tree in India, reckoning its productive capacity to commence at 20 to 25 years, and to extend to about 200 years at which period it could be felled and utilized for fuel or timber, its timber being of excellent quality ; and it is worth while, therefore, having an enumeration made of the trees such as is suggested.

It would be easy to support the statement as regards its comparative financial value by simple arithmetical calculations, framed on the excellent financial results realized from the experimental departmental collection and sale of the seeds alone (*vide* Government Resolution No. 2521 of the 9th March 1908 and subsequent Resolutions in 1910), which showed a net profit of Rs. 2-3-11 per cwt.; and by quoting the enormous annual revenue derived from the sale of the corollas to liquor contractors, which in some years in West Khandesh has exceeded the entire land revenue of the Taluka. Such a calculation, however, would be misleading, as several economic factors would have to be taken into account in comparing results with timber areas which would vitiate the value of the figures.

But there seems little doubt that, in the region where the Mhoura exists, it is *par excellence* the tree whose growth should be encouraged or developed from every stand-point, economic, commercial, financial and climatological, and more especially now when its utility as a source of acetone and its potentialities as a producer of sugar are considered.

11. MHOURA AS AN INDIAN PLANTER'S TREE.

And this leads me up to the question of considering whether it would not be advantageous for Indian gentlemen to cultivate the tree in the same way as Englishmen and others cultivate rubber, etc., in Ceylon and other places?

There are extensive tracts of open land outside forest where *Bassia latifolia* in the north, and probably both *Bassia latifolia* and *Bassia longifolia* in the south, of the Presidency could be grown with profit, provided facilities are offered for such cultivation by the State to Parsee, Mahomedan and Hindu gentlemen. The grazing requirements in the areas so treated would not be interfered with. If a practical demonstration of the probable success of such a measure is sought, one has but to go to the Khaira District in Guzerat, where no State forests exist but where thousands of Mhoura trees can be seen growing

in waste areas. The oil from the seeds here is locally manufactured into soap.

It requires no stretch of imagination to realize that, with the advance of education and increased enterprise on the part of the people, if Mhoura is grown abundantly in other parts and annual supplies *permanently* assured, higher class margarine and soap factories would probably spring up in or near the Mhoura tracts to take the place of those which now exist thousands of miles away in foreign countries in Europe. The value of the unproductive lands in Broach and Ahmedabad could, it is thought, be also considerably enhanced under a well thought-out scheme of planting.

Parsee gentlemen are particularly enterprising in the farming and fruit-growing lines, and educated youths amongst them might find suitable occupation in growing Mhoura or other fruit trees on their lands. Many of the liquor contractors in the Presidency, notably Mr. Cowasjee Dadabhoy Dubash of Bombay, are Parsee gentlemen, and in North Thana there are some well-educated farmers such as Mr. Bhilladwalla. This is the gentleman who, in 1899, gallantly came forward and supplied a large quantity of fodder from the Thana District for the famine-stricken cattle in Ahmedabad in Guzerat when Government measures for their relief had failed. I merely recall this incident as a compliment to Mr. Bhilladwalla and as indicative of his enterprising spirit: and I expect there are others like him. At any rate, there must be Parsee families with sons who might very well be induced to take up the idea of being Planters, just as Englishmen have taken up the growing of Tea and Rubber, etc., elsewhere. The late Mr. Malabari, the Indian Reformer and writer, once asked me what occupation outside the towns could be found for Parsee youths and, at the time, this idea of planting Mhoura in particular never occurred to me.

I submit the suggestion for the favourable consideration of Government as an experimental measure in selected localities, if it is not considered politic to include the trees in waste lands under efficient organized treatment.

12. THE SEEDS OF *Bassia longifolia* PROBABLY BEING EXPORTED FROM INDIA AS "MHOURA SEEDS" BY MERCHANTS.

In 1908-09 a sample of this seed of *Bassia longifolia* from the Southern Circle, Bombay, was submitted by me to Messrs. Ralli Bros. in London for opinion and their report on it was so favourable that I forwarded it to the Secretary of Government, Revenue Department, Bombay, for information and with the suggestion that an experimental shipment of two tons of *Bassia longifolia* might be made to London from the Southern Circle; but my proposal did not meet with acceptance.

The Conservator of Forests, Southern Circle, Bombay, informed Government that the tree, though found throughout the moister forests of Kanara, was nowhere abundant, that the seed was not found in paying quantities and that he could not collect two tons with any facility. It was suggested to me by the Under-Secretary to Government, Revenue Department, Bombay, in his demi-official letter of the 16th February 1909 that 'the facts I had quoted about the value of *Bassia longifolia* seeds would be of more use to the Madras Government than Bombay and that it might be worth while giving it to them.' As I had already written to the *Indian Forester* on the subject (*vide* my article in that Magazine, Vol. XXX, p. 465), the matter then dropped.

In reconsidering the question, however, recently, it has occurred to me to enquire whether the Conservator of that period might not have been mistaken about the true position of *Bassia longifolia* seeds as then existing? My belief is that some seeds of this tree were probably being collected and exported by dealers at the time of his report above quoted from the forests and waste areas of the Southern Circle or Madras Presidency and sent to Bombay. No mention, it is true, is made in the *Dictionary of Economic Products* or other work on Indian Economic Products of the seeds of *Bassia longifolia* being an article of export to Europe from India; but I am induced to believe that it has been an article of such export for some years.

Both *Bassia latifolia* and *Bassia longifolia* are found in Southern India, the former being scattered and not very abundant,

while the latter is more common and bulks very largely in the Nallamalai Hills of the Kurnool District in the Northern Circle, Madras. From information obtained from the Bombay Chamber of Commerce in 1904, it was ascertained that Mhoura seeds were being conveyed to Bombay for export to Europe, *via* Harlapur on the Southern Mahratta Railway. New *Bassia latifolia* and *Bassia longifolia* seeds are morphologically so similar as to be indistinguishable to the ordinary eye when mixed. It appears to me, therefore, as likely that the two were probably being collected from some source in Southern India at the time of my enquiries and booked to Bombay by rail as "Mhoura seeds."

Moreover, no mention in Annual Reports is made of any State exploitation of *Bassia longifolia* or *Bassia latifolia* seeds from Madras or the Southern Circle, Bombay, and I may, therefore, be wrong in my surmise; but the matter is worth investigation. There must have been a leakage of "Mhoura seeds" somewhere, at any rate from Southern India in 1903-04, and probably this leakage continued up to the outbreak of the war in 1914. It may recommence after the war is over, when the export trade in Mhoura seeds is certain to be re-established.

An investigation into the subject is suggested, because a similar leakage was noticed in connection with *Bassia latifolia* seeds from the forests and waste lands of the Northern and Central Circles, Bombay, in 1903-04 when their exploitation was first recommended; but the Conservator of Forests, Northern Circle, at the time, as will be seen from his letter No. 563, dated 31st May 1904, to the Chief Secretary to Government, Bombay (printed as an accompaniment to Government Resolution No. 2918, dated 7th April 1905), reported against my proposal, because he said "much revenue could not be obtained in his Circle from it as the trees were not sufficiently plentiful in the forests and their produce was already largely taken for direct consumption or for barter by the people who had hitherto been allowed the privilege"; and the Conservator of Forests Central Circle, reported very much in the same way about conditions in his Circle. I regret my inability to quote the number and date of the latter's letter, not having kept

a record of it—but this is so according to my recollection. These reports, it must be mentioned, were addressed to Government at a time when merchants were collecting and forwarding the seeds from the Thana, Khandesh and Nasik Districts to Bombay for export to Europe.

I had written a short article after careful investigation into the Mhoura seed question in the *Indian Forester* for December 1903, pointing out the increased demand for the seeds in the European markets, and had estimated the revenue from them available for export to Europe from an insignificant area in the Thana District, Northern Circle (after the domestic and other wants of the local inhabitants had been provided for) at about Rs. 1,635.

The information given in my article seems to have been overlooked. The experimental collection as recommended by me was, however, carried out under the orders of Government in Thana with successful results and it may be interesting to give the actual most recent results of the receipts from this source, for they show that my original estimate of revenue, viz., Rs. 1,635 was prepared with caution.

				Rs.
1910-11	...	...	...	3,049
1911-12	...	...	...	1,955
1912-13	...	...	...	2,468
1913-14	...	...	...	2,229
			4)	<u>9,701</u>

Rs. ... 2,425

The Conservator had traversed the district and, after personal observation and enquiries (*vide* para. in his letter above quoted), had come to the conclusion that, owing to the paucity of the trees, it was not worth while exploiting them for their seeds, and yet from the small number in the district an annual net revenue of Rs. 2,425 has been obtained. This is, if need be, very emphatic evidence of the high value of each tree, apart from the value attaching to the corollas which is even higher. But, in the Central Circle, the information that existed of large exports of seeds which were taking

place from there has been more than confirmed by subsequent results. In consequence of the adverse report of the Conservator, in the first instance, this exploitation was not taken in hand there. Three years afterwards (in 1906), however, I was appointed to hold charge of the Central Circle, and I induced Government to undertake an experimental collection of the seeds in the Khandesh District of that Circle.

The experiment proved so successful that Government ordered the exploitation to be carried out in Nasik also with the results that it has been continued, and for the four years ending 1914 when the war broke out the receipts from Mhoura seeds in the Central Circle have averaged about Rs. 50,000.

The average *net* returns annually are probably about a quarter of a lakh of rupees, a sum not to be despised when it is understood that the Mhoura trees exploited are comparatively few in number, and when the total forest revenue in Khandesh, at the time of the suggested exploitation, barely exceeded the expenditure, and when also in the Panch Mahals and Surat where Mhoura is abundant deficits were apparent. (*Vide* Note on Mhoura printed as an accompaniment to Government Resolution No. 2918 of the 7th April 1905.)

13. OBJECTIONS TO EXPLOIT MHOURA SEEDS IN CERTAIN PARTS OF THE BOMBAY PRESIDENCY CONSIDERED.

Under the circumstances of the above record it is left to Government for decision whether any enquiry and any action shall be taken with regard to the exploitation of *Bassia latifolia* and *Bassia longifolia* seeds in the Southern Circle or elsewhere, and whether any organized schemes, at the same time, shall be introduced for preserving and developing this new source of revenue both where exploitation is carried on under the authority of Government or not.

As shown in the Statement appended, Government exploitation of Mhoura is not carried on in the Panch Mahals and Khaira, of the Northern Circle, where the trees are comparatively abundant both in forests and waste lands. This is because the local Revenue Officers in the Panch Mahals when consulted on the subject

originally vetoed the proposal mainly because, it was alleged, the rights and privileges of the people would be interfered with thereby.

I would invite attention to identically the same objections which were raised against the exploitation of the trees in the Northern and Central Circles originally and which have proved fallacious. This has been explicitly declared to be the case by the Bombay Government in para. 3 of their Resolution No. 3315, dated 28th March 1907, where in issuing orders on the experimental collection of seeds in the Khandesh District of the Central Circle they remarked as follows :—"Government note with satisfaction that so far from the withdrawal of a privilege granted to the Bhils by the North Tapti Code having operated to their disadvantage it has turned to their profit."

The farming out of the right to collect the produce of trees does not interfere with the rights and privileges of the people to that produce, as experience has proved in other districts and as abundantly demonstrated in other parts of India also where Mhoura is also exploited with considerable profit. In what respect, therefore, Guzerat differs from other parts of India, it would be interesting to know? And in what respect also is the legal position of Mhoura there different to that of *Terminalia Chebula*; for instance, in the Southern Circle, as elsewhere, which yields the Myrabolan of commerce and which is exploited by Government? I think these are points requiring investigation because, judging by the reports of the Conservators of Forests, Northern and Central Circles, already alluded to and the report of the Collector of the Panch Mahals No. 2349 of the 30th May 1904 (printed as an accompaniment to Government Resolution No. 2918, dated 7th April 1905), a good deal of misunderstanding seemed to exist about the alleged restrictions which farming out the produce of the trees would impose on the people.

Misunderstanding of this sort results sometimes in serious loss of revenue, as evidence the Central Circle, Bombay, which remained about four years, in spite of admonitions, without State exploitation of Mhoura seeds, involving a net estimated loss of about one lakh of rupees. But exploitation of Mhoura is

recommended not only for the sake of realizing revenue from it, but also to enable organized plans for its future to be framed where the demands of user are heavy, as is the case with Mhoura in the Panch Mahals, Khaira, and elsewhere and it is imperative to meet this demand by properly organized measures—in the interests of the State and people and not to let things drift, if I may be pardoned for so saying, as is being done at present by the Forest Department. The export trade, under present conditions, must, it is believed, eventually fall off and will probably cease altogether in time, unless some such measures are adopted to arrest the evil because it is abundantly proved that in matters of this kind the people do not act for themselves. They live without a thought beyond present necessity. These remarks are not applicable of course to India only, but to exploiters of commercial products all the world over who invariably try to kill the goose with the golden eggs.

14. REFERENCE TO THE REPORT OF THE ROYAL COMMISSION ON NATURAL RESOURCES, TRADE AND LEGISLATION OF THE OVERSEAS DOMINIONS.

I take the opportunity of inviting attention, in this connection, to the report of the Royal Commission on Natural Resources and Trade and Legislation of the Overseas Dominions, wherein the better handling and disposal of the resources of the various parts of the Empire are recommended, and it seems to me that the raw products of the *Bassia latifolia* and *Bassia longifolia*, wherever they are found as export articles, are such as to come under this category.

It is certain that unless some organized plans are drawn up to secure the future of *Bassia latifolia*, and probably *Bassia longifolia*, the supplies of their raw products, especially seeds which are now very variable in quantity each year, will become more so in time and probably cease altogether at any rate for all practical or commercial purposes. With such a prospect in view, it can hardly be expected that European and Indian gentlemen will be induced to sink much, if any, capital in endeavours to establish up-to-date factories in India or elsewhere for the manufacture of the raw products on the spot.

15. CONCLUSION.

Apologies are offered for having written at such length on the subject and for the liberty taken in urging fresh enquiries and for

making the criticisms and recommendations I have, but the interest I continue to take in botanical work and the value, from a commercial, economic and climatological stand-point to the State, which both the *Bassias* alluded to in this report appear to afford will, it is hoped, be considered a sufficient excuse for my doing so.

It would be a failure of duty on my part, if I did not, with the information I possess and with the time at my disposal, take the opportunity, afforded by the reading of Mr. Pearson's extremely interesting paper, of emphasizing the great economic importance of *Bassia latifolia* and *Bassia longifolia* to the people of India, and also of bringing to notice the high financial value of their raw products to the State, and did not at the same time suggest the necessity of some organized efforts generally wherever the trees are now exploited for these products, to cope with the danger which exists of the trees becoming in the future extinct species, at any rate for all practical commercial purposes.

APPENDIX I—EXTRACT.

JOURNAL OF THE ROYAL SOCIETY OF ARTS, 1ST JUNE 1917.

MR. G. M. RYAN, F.L.S., late Indian Forest Service, urged the necessity for the preservation of the trees in India from which Mhaura seeds were obtained for the making of soap, margarine and candles. A danger existed that there might be a serious diminution in the numbers of that valuable tree, and it was most important that it should be regenerated. It was thought by some people in India that the growth of the tree should not be encouraged because it was a source not only of forest fires but also of intoxicating liquor. The natives burned the area around the tree in order to clear the ground so that the Mhouras might easily be collected, and the fires sometimes spread to the forest, but those difficulties might be overcome. The best trees produced about half a ton to a ton, which before the war fetched from 5 to 6 rupees per cwt. in the market, and in a good year the supplies were not available to meet the demand. Most of the seeds unfortunately went to Germany and to the south of France, and he thought special measures should be taken for improving and developing that important source of revenue to the Government of India, and especially that the product should be kept within the Empire.

APPEN-

*Statement of the probable sources of supply of Mhoura Seeds from
State exploitation were undertaken in*

Sources of supply.	Forests in tons.	Waste lands in tons.	Price per cwt. in Rs.
I	2	3	4
BOMBAY PRESIDENCY.			
NORTHERN CIRCLE.			
Forest Divisions and Waste Lands.	Panch Mahals <i>not exploited</i> ... 1,600 Surat including Dangs ... 400 North Thana exploited ... } Central Thana „ ... 100 South Thana „ ... }	... ... ... ...	I I I I
Non-Forest Divisions.	Khaira District <i>not exploited</i> ... Ahmedabad „ ... Broach „ ... Other Districts „ ...	... 2,400	I
CENTRAL CIRCLE.			
Forest Divisions and Waste Lands.	Nasik exploited ... 500 West Khandesh „ ... 1,000 East „ <i>not exploited</i> ... ...	... ... ...	I I ...
SOUTHERN CIRCLE.			
	Kanara ... Bassia longifolia chiefly <i>not exploited</i>.	... Unknown...	.........
MADRAS PRESIDENCY.			
NORTHERN CIRCLE.			
Forests ...	Kurnul District <i>not exploited</i> ... 500	...	8
Waste Lands ...	Kurnul District „ ...	500	8
BENGAL.			
Forests and Waste Lands.	Chota Nagpur ... Bihar and Orissa ... United Provinces ... Punjab ... Central Provinces ...	... ... 7,000	12
NATIVE STATES.			
	Baroda ... Rajputana ... Indore ... Hyderabad ...	... 12,000 ... ...	... 12
Total	...	...	...

DIX II.

all India and the Estimated Income derivable therefrom if their Forests and Waste lands generally.

Value.	Total.	Total British India.	Total Native India.	REMARKS.
5	6	7	8	9
Rs.	Rs.	Rs.	Rs.	
32,000	<p>It is necessary to explain that the figures entered in column 2 are based on the total average exports of seeds from all India as quoted in para. 6 of my Report. The details of quantities exported from each locality are approximate figures only estimated to the best of my ability. The average price of Re. 1 per cwt. entered in column 4 as the value of seeds in Bombay is not excessive, bearing in mind the fact that the net price obtained before the war in Khandesh sometimes exceeded Rs. 2 per cwt.</p> <p>The estimated outturn of 400 tons from Surat and the Dangs may be considered too sanguine since only a small income from Mhoura is now realized in Surat—but this is probably because of the duty of 1 anna per maund levied by the State on Mhoura. It would be preferable to forego the paltry revenue of about Rs. 100 annually here and to farm out the collection of the produce instead, permitting the people to collect the produce for sale free of charge.</p>
8,000	...	...	...
2,000	42,000	...	...
48,000	48,000	...	...
10,000	...	...	...
20,000	30,000	...	...
...	...	1,20,000	...	
...	10,000	10,000	...	
...	1,05,000	1,05,000	...	
2,80,000	...	...	1,80,000
...	...	2,35,000	1,80,000	

IS SPIKE DISEASE OF SANDAL (*SANTALUM ALBUM*) DUE
TO AN UNBALANCED CIRCULATION OF SAP ?

BY K. R. VENKATARAMA AYYAR, EXTRA-DEPUTY CONSERVATOR OF
FORESTS, MADRAS.

The most interesting and instructive article, on the cause of spike disease of Sandal, contributed to the October number of the *Indian Forester* by Mr. R. S. Hole, is so full of convincing arguments in support of the theory he has advanced, that it seems necessary to examine and find out how far the facts ascertained in the Sandal areas elsewhere will bear out his theory.

2. In his able article, Mr. Hole, who has gone to the very root of the question, has explained why he believes that spike is apparently not really infectious. My acquaintance with spike in Sandal dates from the year 1903 and having watched the progress of the disease in areas where I have worked, I feel that the reason given against the infection theory is sufficiently convincing. But the only point on which an explanation is, perhaps, necessary is why, if spike is due to natural causes such as those mentioned by Mr. Hole, the disease was not known to affect sandalwood anywhere prior to the year 1898, when it was first discovered in Coorg. The natural causes such as fire, damage of hosts and suppression must have also existed then, and unless it be that Forest Officers were less observant at the time than later, the absence of the disease during the earlier period would appear to remain unaccounted for. I do not think it can be seriously contended that the rapid spread of lantana, in recent years, has brought about new conditions favourable for the appearance of spike, as this disease is known to exist even in areas where no lantana grows.

While it is not my purpose in this article to discuss whether spike is or is not an infectious disease, I feel I have to place on record certain observations which have been made in the Sandal areas in the South Vellore Division, as they do not appear to support the theory advanced by Mr. Hole, that the disease is due to an unbalanced circulation of sap caused by a number of different factors which are said to be primarily—(1) Fire, (2) Death

or damage of hosts, (3) Partial suppression, and (4) Exposure of trees hitherto growing under shade.

3. For the experimental proof or otherwise of the theory, Mr. Hole has suggested a few simple forest experiments of which he has given six examples. A few experiments, somewhat on the lines of those indicated by him, have been carried out in the Sandal areas of the South Vellore Division, and though it is perhaps too early yet to draw any definite conclusions therefrom, I think that the facts hitherto ascertained might be stated so as to invite criticism. I must, at the outset, state that spike disease has not yet made its appearance in Sandal anywhere in the areas in the South Vellore Division, though *Zizyphus Ænoplia* is commonly found spiked, and has long been known to be spiked everywhere. The annual rainfall in the locality is about 40 inches.

4. The experiments carried out in the Division were designed to find out the effect of :—

- (1) Isolating the Sandal tree from all possible hosts.
- (2) Injuries of various kinds to the root-system of Sandal.
- (3) Girdling the Sandal, and
- (4) Exposing Sandal trees hitherto buried up under a dense mass of creepers.

In addition to these experiments, observations have also been made in the forest, to find out the health condition of the Sandal trees which were very seriously damaged by a violent cyclone that passed over the area in November 1916, which, in nearly every case, appears to have produced an unbalanced circulation of sap in the tree without actually producing spike in it. It is the purpose of this article, therefore, to summarize the results of these observations.

5. The first of the experiments was carried out to ascertain if Sandal was an obligate root-parasite. With this object, one Sandal tree 18 inches in girth, which had no other tree or shrub within a radius of 12 feet, was selected in February 1916 and a trench was dug to a depth of 2 feet all round it. This depth was increased in September 1916 to 3 feet where the soil is hard kankar. The diameter of the platform enclosed by the trench is 16 feet. The

section of the cutting made for the trench showed that no lateral roots of any species were embedded in the ground lower than about $1\frac{1}{2}$ feet from the surface. At the same time as the tree was entrenched, the platform enclosed by the trench was dug up, and all surface roots of grass, etc., were removed from it, and every possible precaution was thereafter taken to keep the platform always absolutely clean and prevent any weeds or grass from growing on it. In cutting the trench round this tree (Tree No. 1) all its lateral roots were cut through with the result that the tree was entirely isolated and deprived of any possibility of getting the necessary water-supply from its hosts.

In August 1916, *i.e.*, six months later, the same experiment was tried on six other Sandal trees (girths varying from about 11 to 15 inches) in the immediate vicinity of tree No. 1 and, in all cases, the trench was carried down to a depth (mostly 3 feet) where the subsoil was very hard and where no lateral roots of any other species were found embedded. All the seven isolated Sandal trees, which had all their lateral roots cut through, are situated in a fenced area, and, fortunately for the experiment, none of them were blown down by the cyclone in November 1916 though their roots were violently shaken by it.

6. Mr. C. E. C. Fischer, the then Principal of the Madras Forest College, at whose encouragement this experiment was started, very kindly inspected the trees in September 1916 and recorded his observations on the then health condition of each tree. He had then remarked that four of the trees presented only an average appearance of health, while three others looked unhealthy. In most cases, the crowns were small, the foliage was incomplete and a number of dead twigs were found at the ends of branchlets. In recording these observations, he had also noted that these seven Sandal trees did not materially differ from the generality of Sandal trees in the immediate vicinity. All the seven trees have their crowns free and fully exposed to the sun. All except one tree were found to have their normal apical growth, with a full length of cambium and conducting tissue, though the foliage, in most cases, was deficient at the time the experiment was

started in February and September 1916. In the case of one tree only, there was some sign of stag-headedness.

It will, therefore, be clear that the test made is a very severe one and is calculated to deprive the tree of any chance of drawing its water-supply from its hosts, and thus to bring about the condition sufficient for an unbalanced circulation of sap. In every one of these cases, the rate of upward flow of water must have been diminished by the damage to the roots of the Sandal and of its hosts.

The experimental plot is situated in the head-quarters of a Deputy Ranger who is required to inspect the trees at least once a week, and submit a certificate at the end of it to say that the platform was kept clean and the trench was in order. Between September 1916 and January 1918, the trees were inspected twice by the Conservator of Forests, Mr. P. M. Lushington; first in December 1916 and afterwards on the 20th January 1918, and on both these occasions he was pleased to record his observations on their health condition in the District Sample Plot register. I have myself personally watched the progress of these trees every three months and noted down my observations on the spot in the Sample Plot register. The Conservator of Forests personally satisfied himself with the precautions taken to prevent the possibility of any weeds, etc., from growing on the platform enclosed by the trench, in the case of each Sandal tree experimented on. The very hard beaten nature of the surface of the platform is sufficient testimony to its being continually trodden upon for the purpose of examining if any weeds grow upon it. Every time an inspection was made, the fact whether the platform was clean was noticed and a record that it was so was invariably made. It was also observed on examining the section of the cutting on the inner edge of trench that all embedded roots of species other than Sandal had died out.

7. In all these cases, most magnificent reproduction from root shoots has appeared on the outside edge of the trench, the shoots coming out of the cut ends of the lateral roots of the entrenched Sandal, whose haustorial attachments outside the

trench had not been severed. In some cases, root shoots appeared on the inner edge of the trench, but they were found to belong to other distant Sandal trees which had sent their lateral roots towards the entrenched Sandal trees. These shoots, however, all died out at an early stage.

The entrenched Sandal trees, seven in number, have, up to date of writing this article, shown no sign of spike though one tree has remained in complete isolation now for two years and the others for one year and six months. A photograph of the former, which (Plate 19) was taken for me by Mr. C. Srinivasa Rao, student of the Madras Forest College in October 1917, will show the present health condition of it. On 20th January 1918, the same tree was inspected by the Forest Commissioner who was pleased to take a photo of it, to show the platform, the trench and the magnificent root shoots growing on the outside edge of trench.

The above experiment, in addition to showing the remarkable vitality of Sandal, seems to show that the unbalanced circulation of sap, which must necessarily have been caused by isolating the trees and cutting through the roots by deep trenches thereby greatly diminishing the supply of water and nourishment, has not produced spike.

8. The other experiment that was carried out is in the compound of the Forest Rest-house at Andiappanur and was started on 4th September 1916. Four very healthy Sandal trees planted in 1904 alongside the live fence of the bungalow compound were selected for the experiment. The lateral roots, in the case of every tree, were exposed one after another and strong sulphuric acid was injected into them at various intervals along their whole length. In addition to this treatment, all root attachments were severed in the case of one tree, and in the case of two others the removal of the haustoria was followed up by cutting out the ends of all lateral roots and rootlets. After these operations were performed, the roots were covered up again with earth. There was practically no change in the health condition of any of these four trees when they were inspected in December 1916, and also thereafter at the end of every three months. The trees were last inspected by the



Photo-Mechl. Dept., Thomason College, Roorkee.

Photo by C. Sirinivasa Rao, October 1917.

Sandal tree isolated in February 1916. View showing the trench dug to isolate the Sandal tree and the platform kept free from grass, etc. South Vellore Division, Madras.

Conservator of Forests in November 1917, when these were found to be generally very healthy with dark green leaves and abundant foliage. The lateral roots of these trees were then again exposed one after another under instructions of the Conservator of Forests when the effect of the past maltreatment was closely studied. It was then found that wherever a severe injury was caused to the root, either by the injection of the sulphuric acid or by the cutting away of the root-ends, fresh roots have grown out from the injured places which had, within a short time, made most marvellous growth in length and secured, in some cases, new attachments. In November 1917, much more severe injuries were made to the roots which were again covered up and the result is being carefully watched. The injury done to the lateral roots, in the case of these four Sandal trees, in September 1916, is perhaps not less severe than the damage by fire to the roots which is considered likely to produce spike. The amount of maltreatment done to the roots in September 1916 should, in my opinion, have been sufficient to cause an unbalanced circulation of sap in a tree which till then was growing under the most normal conditions and yet none of the trees was spiked.

In a 5-acre plot at Amerdi containing 20 to 30 Sandal trees per acre, teak was planted during May and June 1917. In the hot weather of that year all trees other than Sandal in that plot were felled for the purpose, and their roots grubbed out. After the removal of the felled trees, all the unsaleable brushwood was made into heaps which were scattered about the area and they were fired. The fire was so intense that, in some cases, the neighbouring Sandal trees were killed outright, whilst others were badly scorched by it. These latter were, for some time, bare of leaves which wilted away, but with the first burst of the monsoon in July, new flush began to appear and the trees, in most cases, have put on their normal foliage. In no case was spike observed as a result of this firing. The same operation in another 5-acre plot was carried out in 1916, immediately adjoining the 1917 plantation where there was an equally large number of Sandal trees, and none of the Sandal trees that survived got spike. It must,

In this connection, he said that the Sandal trees about this locality were tall luxuriantly grown ones on an alluvial soil and, before the clearing was made for the plantation, every one of the Sandal trees was growing amidst good hosts with plenty of lateral shelter and overhead light and with good normal crowns and foliage. The sudden removal of all the hosts which were, for the most part, grubbed out and the subsequent injury by fire caused to the roots and lower portions of the stem of the Sandal trees that survived the fire, should, I think, have produced all the conditions necessary for an unbalanced circulation of sap, but spike has all the same not been observed in anyone of the trees.

9. The third experiment, *i.e.*, girdling healthy Sandal trees, was started in the year 1913 with a view to find out if it would tend to an increased production of heartwood. Six very healthy trees of about 36 inches girth were selected for the purpose and the girdling was made in each case right into the heartwood. Periodical observations were made and it took nearly three years for the trees to completely die, and even then it was the portion above the girdle that dried up in each case and not the portion below it. In none of these cases was the tree observed to be spiked, though an unbalanced circulation of sap must probably have been caused in each case as a result of girdling, which must have interfered with the translocation of the organic food by reason of the stoppage of water from the roots. In the Chengam Range of the West Vellore Division, where dying Sandal trees are systematically being girdled for extraction two years later, no spike has up to date been observed. All girdling in these cases is carried out at the base of the tree. This, in practice, must have, in my opinion, the same effect as causing serious injury to the roots as in both cases, the upward flow of water must either cease or diminish greatly so as to produce an unbalanced condition in the circulation of sap. In the case of a Sandal tree girdled deep into the heartwood at its base, the upper portions of the tree must obviously depend on the tissues of the stem above the girdle for the supply of water, and this being insufficient for the growth, and nourishment of the long length of cambium above the girdle and for the translocation

of carbohydrates, an accumulation of carbohydrates must soon result in the leaves leading to spike, according to the theory advanced by Mr. Hole, if I have correctly understood the exact significance of the term "Unbalanced circulation." This, however, has not been the case and the tree died slowly without any outward sign of spike.

10. The exposure of Sandal trees growing under suppression forms part of the prescriptions of the Sandal Working Plan in the district; and under this Working Plan which came into force in 1915, thousands of Sandal trees which till then were buried under creepers were systematically relieved from suppression. Trees treated in this way were inspected by the Conservator of Forests, Mr. P. M. Lushington, who writes thus in his Inspection Note dated 21st December 1916: "The crowns of all trees in the tended area are now released, and it is only necessary to see the large number of trees with poor crowns to judge how they have been overwhelmed with creeper." In spite of such sudden exposure of these trees and the increased loss of water which must have occurred from the transpiring leaves of a disproportionately small crown and a poorly nourished cambium of the tree which had long remained under suppression, spike has not appeared in any single case. Nor has this prolonged suppression of Sandal by creepers or other growth ultimately caused spike in any single case up to date in the Sandal areas of the South Vellore Division.

I have, in the foregoing paragraphs, attempted to show how the theory advanced by Mr. Hole is not in accordance with facts ascertained in the Sandal areas of the North Arcot District. Every one of the four primary factors believed by him to cause spike has not so far been able to produce spike in Sandal in the area under reference. It is possible that the experiments have not been carried out on the exact lines suggested by Mr. Hole and do not justify the present conclusion, but it is hoped that defects, if any, in the experiment will be pointed out.

11. The cyclone of the 22nd November 1916 did enormous damage to the Sandal trees in the North Arcot district and

Mr. Lushington in his Inspection Note, dated 21st December 1916, thus tersely describes the damage :

"Everywhere in the patta fields, the porambokes, the wastes and the reserves, trees of every description have been blown over or completely topped. In other cases, limbs large or small have been blown off. * * * "

"Many trees have been completely uprooted, others have been torn from the ground and are leaning over and nearly every tree has been badly shaken. Some trees are completely bereft of their crowns, others have lost a large limb and others still have limbs broken and the leaves blown off. There is hardly a tree left standing that has not received damage in some way or other."

All irretrievably damaged trees were removed but, in a large number of cases, trees still continue to live apparently in best of health, even where all but a single lateral root had been completely exposed and the tree itself blown down. With such great injury to most of the roots which have lost all their attachments, the trees continue, in many cases, to live apparently in best of health and produce dense foliage. These are, I suppose, instances where an unbalanced circulation of sap in the tree must have resulted but without the trees getting the disease. In a large number of other forms of injury caused by the cyclone to the roots, stems and branches of the Sandal tree, no spike has appeared though, in some at least of those cases, an unbalanced circulation of sap must have set in.

I, therefore, venture to ask whether, in these circumstances, the spike disease of Sandal is due to an unbalanced circulation of sap and if so, whether it is caused by the four primary factors alluded to by Mr. Hole.

SPIKE DISEASE OF SANDAL.

BY R. S. HOLE, I.F.S., FOREST BOTANIST.

1. Mr. Venkatarama Ayyar's article on the cause of spike which is published in this number of the *Indian Forester* is a most interesting and valuable one, inasmuch as it records the results of careful experiments designed to test the effect of individual factors on the health of Sandal and describes the conditions under which the experiments were carried out. It is by work of this kind that the various causes of spike which have been suggested from time to time can be satisfactorily tested and that real progress in our knowledge of the disease is likely to be secured. At the same time such progress must be retarded if we reject possible causes on insufficient evidence and shut down experiments regarding them before they have been thoroughly and exhaustively tested. In the hope that they may encourage the extension and continuation of such experimental work, the following notes are offered on the various points raised by Mr. Ayyar:—

2. *If spike may be caused by natural causes why did it not appear before 1898.* The fact that spike in Sandal was first brought prominently to notice in 1898-99 is no proof that the disease originated about that time. Attention has only recently been drawn to the occurrence of spike in *Zizyphus Ænoplia* but inquiry has now shown that this disease occurs practically throughout the Peninsula of India and it has almost certainly been in existence for a long period. Although *Trametes Pini* was first definitely reported in India in 1904, there is no doubt that this fungus was widely distributed in the Punjab hills long before this date. The fact that spike in Sandal first attracted serious attention in Coorg in 1898-99 may merely indicate that, in that locality, at that time, spike had become unusually prevalent and if so, in Coorg at any rate, this unusual prevalence appears to have been coincident with the spread of lantana.

3. As regards the bearing of Mr. Ayyar's experiments on the theory that spike may be caused by an unbalanced sap-circulation, a reference to pp. 430, 431 of the *Indian Forester* for October 1917

will show that this theory postulates a condition under which carbohydrates accumulate in the leaves and branches and that this condition should be *prolonged*. That various factors may be responsible for an unusual accumulation of starch in the above ground parts of green plants is well known and among such factors are a deficiency of an essential nutrient substance, an acid soil, a deficiency of water and interference with the translocation of organic food. Sucking insects and the hyphæ of various fungi are probably also able to produce carbohydrate accumulation partly by the actual abstraction of moisture from the plant cells and partly by damage to the conducting tissues. The point which requires to be proved is whether this carbohydrate accumulation can be carried to such a point as to produce the pathological condition known as spike. To test this theory, therefore, it is necessary to select one of these various factors, to arrange the conditions of the experiment in such a way that the intensity of the factor is sufficient to cause an accumulation of carbohydrates and finally to see that this condition is *prolonged*. Until these conditions have been fulfilled the theory cannot be said to have been tested.

4. Mr. Ayyar's first experiment deals with the isolation of Sandal trees by means of trenches. If it is subsequently proved that the roots of other plants have been effectively excluded from these enclosed areas and that the isolated trees remain healthy for a considerable period, the results obviously indicate that Sandal is not an obligate parasite but can, under some conditions at least, obtain its supplies of water and salts from the soil by means of its own roots. Some experiments which are being now carried out at Dehra Dun appear to point to the same conclusion and it is quite possible that in some localities Sandal is more independent of host plants than in others, on account of better, moister soil, heavier rainfall or other conditions. Assuming that Sandal can maintain itself without host plants in the locality, the cutting of the lateral roots 8 feet from the tree might do no more than cause a temporary decrease in the water-supply which would rapidly be made good by a vigorous development of adventitious roots. It

is obviously important to watch the future development of these isolated trees, to record their girth development and compare it with that of similar control trees in the neighbourhood and also to see whether or not the treatment has any effect on the starch content of the leaves and twigs. I would also suggest that similar experiments should be carried out in different localities on different types of soil to see whether the dependence on host plants does vary. In one case at Dehra Dun the removal of host plants has been followed by a stag-headed condition, while in another case the effect has been more gradual with less stag-head accompanied by a marked accumulation of starch in the leaves. So far as possible, the experiments should aim at producing and prolonging this latter condition. In localities where Sandal is mainly dependent on host plants the sudden and entire removal of all the latter would be more likely to cause death or stag-head. The gradual killing of the principal hosts near the Sandal trees, perhaps by girdling, would probably give the best results. With reference to this point it is interesting to note that Mr. Tireman has recently visited a place in Coorg where a spiked Sandal was discovered a year ago. This is over $3\frac{3}{4}$ miles in a straight line from the nearest previous attack and is separated from the latter by a hill range, the lowest point of which is 500 feet above the average level of the country. The attacked tree was practically touching an *Albizzia stipulata* which is now nearly dead and which Mr. Tireman thinks has been dying for 2—3 years. The roots of the *Albizzia* were extensively rotted by a fungus which could not be identified owing to the absence of sporophores.

5. As regards damage by fire Mr. Ayyar quotes two cases where severe burning has produced no spike. The writer has also seen several such cases. In *Indian Forester*, 1917, page 433, an attempt was made to explain that it was only under certain circumstances that fire seemed likely to produce the conditions necessary for spike, *i.e.*, when the damage was such as to diminish the water-supply and interfere with the translocation of organic food without materially damaging the upper portions of the stems and branches. With reference to this point it is remarkable that spike

in Sandal is worst in Coorg in dry stony areas subject to fires and densely stocked with lantana. In such localities lantana does not attain a great height but forms a low very inflammable cover. The roots of lantana, also, which are here extensively parasitised by the Sandal are very superficial while the stony dry soil naturally renders these roots more liable to fire damage than would be the case in a deep moist soil. Here, therefore, we have a combination of factors which would render fire most effective in retarding the water-supply and the translocation of organic food without seriously damaging the upper portions of the stem and branches of Sandal. In *Indian Forester*, 1917, p. 438, therefore, it is stated that the fire experiments should preferably be conducted in "dry localities with a small rainfall or shallow stony soil well stocked with lantana." This remark refers to Coorg which I have personally seen; but in other districts where lantana sheds its leaves in the hot season it is possible that fire may not be severe enough to cause spike. In any case it is obviously advisable to burn for at least two years in succession and, if possible, to compare the starch content of sample trees in the burnt areas with that of control trees in unburnt areas.

6. The writer has seen cases in the field where mere cutting and local injury to the roots of Sandal has been followed by a strong growth of vigorous adventitious roots. Such damage, if severe, might be sufficient to cause a condition of stag-head but the shortage of water would soon be made good by the additional adventitious roots and it would apparently be difficult to produce in this way a prolonged condition of slightly deficient water-supply such as is believed to be one of the causes of spike. No experiments on these lines, therefore, were suggested by the writer and it is interesting to note that Mr. Ayyar's experiments in cutting and injuring roots and his observations on damage to roots by a cyclone indicate that spike is not easily caused in this way.

7. Mr. Ayyar points out that, although thousands of trees have been freed from suppression in the South Vellore Division and large numbers of Sandal have been there exposed to prolonged suppression, no single case of spike has occurred among them. The same remarks apply equally well to considerable areas in

Coorg but this does not alter the fact that in many of the dryer forests of Coorg there does appear to be a distinct connection between the incidence of the disease and a condition of slow suppression in which the lower branches and twigs are slowly but steadily killed off although the apical growth of the upper branches still continues. Also in such areas, so far as can be judged by direct field observations, sudden exposure of the upper branches to full sunlight certainly appears to favour the disease. Experiments have now been initiated in Coorg, the object of which is to definitely prove whether or not suppression and the exposure of suppressed trees does here increase the incidence of the disease but detailed study of the effect of suppression, under varying conditions of growth, on the accumulation of carbohydrates in the plant will be required before we can hope to arrange our experiments in such a way as to produce spike by suppression at will, under varying conditions of soil, climate and growth.

8. Mr. Ayyar also points out that girdling Sandal trees into the heartwood resulted in the death of the portion of the trees above the girdle and not in spike. The writer has seen no cases which indicate that spike can be caused by girdling and no experiments in this direction were proposed by him. Sudden and drastic interference with the water-current such as would result from girdling to the heartwood would naturally be expected to produce stag-head as in the case of severe damage by drought. At the same time a method of girdling which interferes with the translocation of carbohydrates without suddenly checking the water-current might, possibly, in time produce the disease by causing an excess accumulation of carbohydrates above the girdle, a gradual starving of the roots and a slow diminution of the water-current. It would, therefore, be interesting to try the effect of girdling by removing (a) bark alone and (b) bark with some of the outer sapwood. It would be necessary to prevent the development of leafy twigs and branches below the girdle as well as the production of root-suckers.

9. In March 1917, the writer circulated to officers interested in this question of the spike disease a preliminary note on spike and the following extracts are taken from that note :—

"The fact which struck the writer most forcibly during the present tour was the extraordinarily widespread damage to the crowns of the trees caused by the dying back of the twigs. * * This kind of damage, while as a rule only slightly, if at all, checking the apical growth of the branches, results in an abnormally thin crown containing quantities of dead twigs and is, therefore, different from the condition usually called "stag-headed," which is characterized by the death of entire branches from the apex downwards * * Judging from the limited areas and number of spiked trees seen during the present tour, it appears to be a fact that, in Coorg, spike does not as a rule appear in a plant which hitherto was perfectly healthy and had developed normally but follows after a more or less extensive and repeated damage to the twigs. If the branch of a healthy Sandal tree is examined it will be seen that, accompanying the continued apical growth of the branch, is a correspondingly vigorous development of lateral twigs from the older portions of the branch. To some extent at least, these lateral twigs must be responsible for the nutrition of the cambium in the older portions of the branch and for the continued production of new and effectively conducting tissue for the transport of water in the wood upwards to the terminal twigs and for the translocation downwards in the bast of the organic food material manufactured in the leaves of the terminal twigs. It seems possible, therefore, that interference with this normal development by the repeated killing off of the lateral twigs may result in abnormal apical development coupled with more or less stagnation of growth in the older portions of the branches. The latter would cause a slowly decreasing water-supply to the terminal twigs and a gradual accumulation of organic materials such as starch in the twigs. Such a condition of affairs would sooner or later result in the death of the roots from starvation and thus the two chief characteristics of spike might be produced. * * The factors (causing the damage to the twigs) which at present appear to deserve most attention are:—

- (1) *Insects.* Signs of damage done apparently by sucking insects, probably scale insects or aphids, were frequently found on the damaged twigs. * *

(2) *Parasitic fungi.* Many of the dead twigs contained the hyphæ of an apparently parasitic fungus. This requires to be identified and its connection, if any, with the fungus commonly seen on the peduncles of lantana carefully studied. * *

(3) *Bad soil aeration.* * *

Finally, it is interesting to note that the specimens of spiked *Zizyphus Ænoplia* obtained during this tour indicated that in this species also, in the specimens seen, the first appearance of spike was preceded by the death of the lateral twigs. In the dead twigs the hyphæ of a fungus have been found, but whether this is the primary cause requires further study."

10. A subsequent tour in Coorg brought to light cases of spike in Sandal in which there was no marked previous dying of the twigs but which appeared to be correlated with the gradual death of neighbouring host plants. In order to include cases of this kind and at the same time to afford a reasonable explanation of the other known facts, the theory was then put forward that spike was due to a prolonged condition of unbalanced sap-circulation which might be due to a deficient water-supply, to any factor which retards growth without interfering with photosynthesis, *e.g.*, a deficiency of an essential nutrient substance like phosphorous, or which interferes with the translocation of organic food, *e.g.*, damage to the conducting tissue of the cortex (*Indian Forester*, 1917, pp. 430, 431). At the same time stress was again laid on the importance of the death of the lower lateral twigs and the apparent effect of fire damage and suppression in this connection (*l.c.*, pp. 431—434).

11. The writer has recently studied an area near Dehra Dun, where spike in *Zizyphus Ænoplia* is very prevalent and where, so far as can be judged from direct observations in the field, spike follows after a more or less prolonged period of damage to the lower lateral twigs, just as has been seen to be the case in Coorg. In the present case, however, the area in question is not subject to fires and the damage is apparently due to a fungus, the hyphæ of which are found in the leaves and twigs. The fungus associated with this damage has not yet been definitely identified but is

possibly a species of *Cladosporium* or *Phoma*. Whether or not the fungus is the primary cause of the damage remains to be proved by inoculation experiments. A number of plants showing this type of damage are now in cultivation in the Dehra garden where they are being kept under careful observation and the effect tested of endeavouring to keep some of the plants free from the fungus by removing the damaged twigs and spraying. Plate 20, fig. 1, shows a branch of *Zizyphus Ænoplia* collected in Coorg which shows the commencement of spike following extensive damage to the lower twigs. Plate 20, fig. 2, shows a branch of the same species collected near Dehra Dun in which spike has also followed the death of the lower twigs, the apical portion of the branch being still healthy. Plate 21 shows *Zizyphus Ænoplia* plants now growing in the Dehra garden which are not yet spiked but which show the death of the lower laterals, the upper twigs being still healthy. The continued checking of growth and interference with normal nutrition in the lower portions of the stems would be expected to cause a local accumulation of carbohydrates which would tend to be increased by the failure of the poorly nourished conducting tissues to carry away rapidly to the roots the organic food manufactured in the uninjured upper branches. These cases indicate the importance of leaf and twig destroying fungi as one of the possible causes of the disease and it is hoped to pay special attention to this point during the coming rains and with special reference to the connection, if any between the fungi occurring on *Zizyphus*, *Santal* and *Lantana* and also to the effect of such factors as water-supply, fire and suppression on the development and injurious action of these fungi. It should be noted that the possible importance of fungi in connection with spike was first emphasized by Mr. H. A. Latham who, in a letter to the writer, dated 4th August 1916, pointed out that spike was associated with the death of the leaves, flowers and twigs and the appearance of fungal sporophores on the leaves and flowers. Specimens of the fungus, however, were not sent to Dehra. In the Madras Presidency Annual Forest Report for 1915-16, p. 22, also, Mr. Latham wrote: "Careful inspection with a lens of leaves and flowers which have recently died on spiked

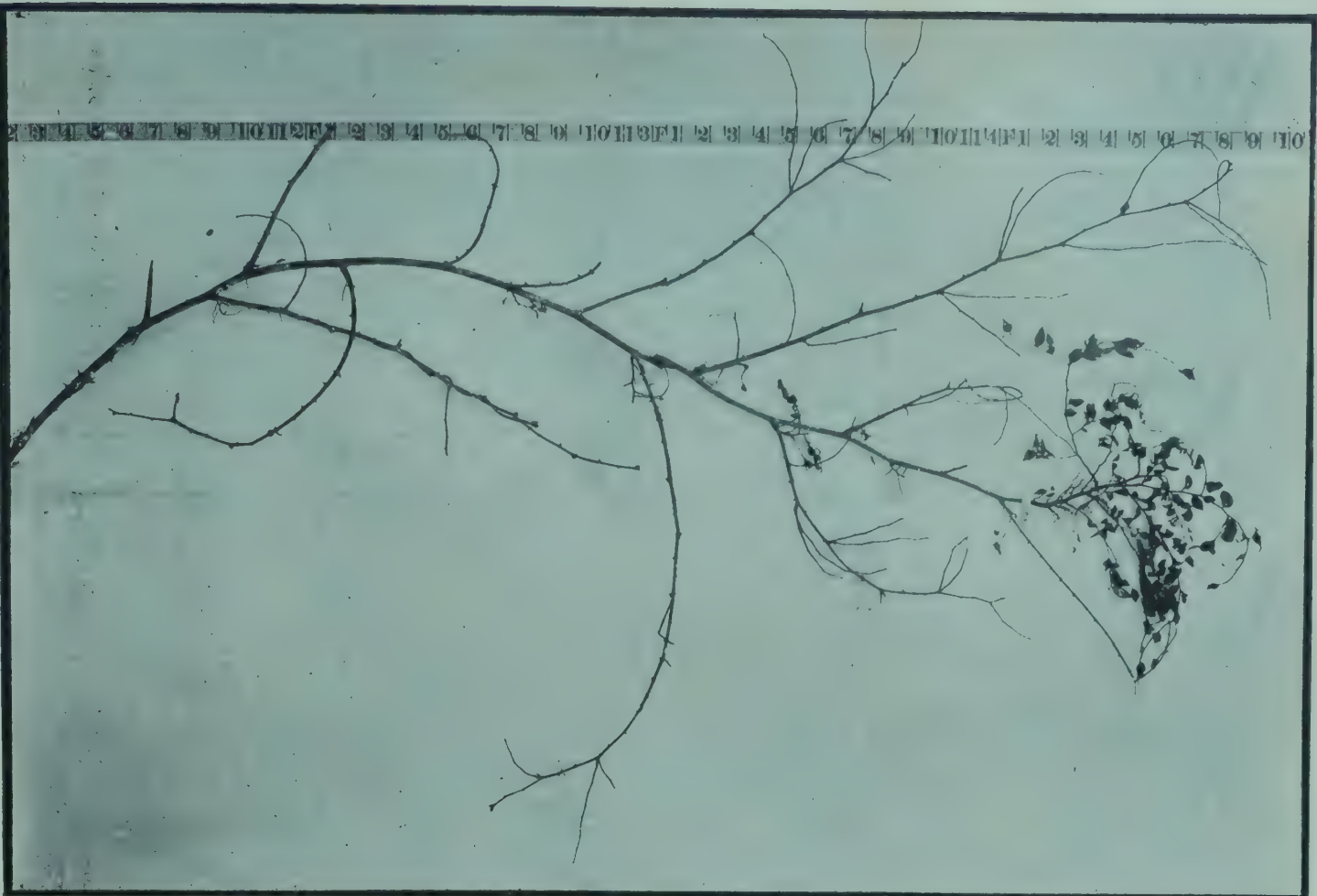


Photo-Mechl. Dept., Thomason College, Roorkee.

Fig. 1. Branch of *Zizyphus Oenoplia*, collected in Coorg, which shows spike appearing subsequently to extensive damage to the lower lateral twigs. At the extreme apex the twigs are still healthy.



Fig. 2. Branch of *Zizyphus Oenoplia*, collected near Dehra Dun, showing healthy twigs at apex and spike below following damage to the lower lateral twigs.

trees in wet weather often shows black sporophores with spores attached ; whether these follow or cause spike, the writer is unable to say ; he thinks the first sign of spike is the death of individual inflorescences as a whole and their not falling, normally the flowers appear to drop one by one often before they are quite dead."

12. With reference to the above suggestion that fungi are a possible cause of the disease, it may be asked why, if this is so, has the fact escaped the notice of those mycologists who have already studied the disease and why has this possibility been negatived by practically all those who have studied the disease up to date? The following points, it is believed, supply the answers to these questions and also indicate how the various difficulties are met by the theory of an unbalanced sap-circulation :—

- (1) The primary damage done in causing the death of the attacked leaves and twigs is apparently quite insignificant and does not, as a rule, immediately result in spike. The damage done, in fact, is apparently often made good by the production of new normal leafy shoots from dormant buds. Such damage does not give the impression of being at all serious in the case of plants like Sandal and *Zizyphus Ænoplia* which are notoriously resistant to damage by mutilation. At first sight, therefore, the possible effect of repeated and gradually extending damage of this kind on the nutritional processes of the plant as a whole and especially on the sap-circulation and movements of carbohydrates is not evident and might be easily overlooked.
- (2) The fungi apparently responsible for the damage are often found on trees which are not yet spiked. Under the theory of an unbalanced sap-circulation, however, spike is believed to be the final result of a prolonged injurious action and damage by such fungi would, therefore, be noticeable some time before the appearance of spike. It must also be remembered that the damage done by such fungi almost certainly depends to a considerable extent

on the vigour of individual plants and whether or not the conditions for their growth are favourable.

- (3) If the disease is due to a fungus which is a strong parasite capable of attacking perfectly healthy individuals, we should not expect to find plants remaining apparently healthy for considerable periods which are in the immediate vicinity of spiked individuals, yet this does undoubtedly happen in the case of Sandal. This, however, may quite well be explained by the fact that many fungi can only gain an entry into the tissues of a plant when the latter is already in an unhealthy condition or when an area of dead or wounded tissue facilitates an entrance. In the case of such fungi grafting would probably facilitate infection.

- (4) In some spiked individuals fungi may apparently be absent. According to the theory of an unbalanced sap-circulation, however, spike may be caused not only by fungi but by the prolonged action of various factors which are able to cause an accumulation of carbohydrates in the leaves and twigs.

13. In conclusion, while urging the importance of an extended scheme of carefully designed experiments to test the effect of the various factors which have been suggested as possible causes of spike, the writer would emphasise the desirability of not confining these, as is sometimes suggested, to those areas where spike is not yet known to occur. We want to know not only what factors are able to give rise to spike in areas where spike has not yet occurred but also what influence the various factors have in increasing the virulence of the disease in areas which are already infected. One of our chief objects is clearly to discover as quickly as possible a practical means of preventing, or, at all events, of decreasing the incidence of the disease and in this connection such experiments as those of Mr. Tireman which have shown that eradicating lantana may reduce the incidence of the disease by 50 per cent are obviously of the greatest importance.

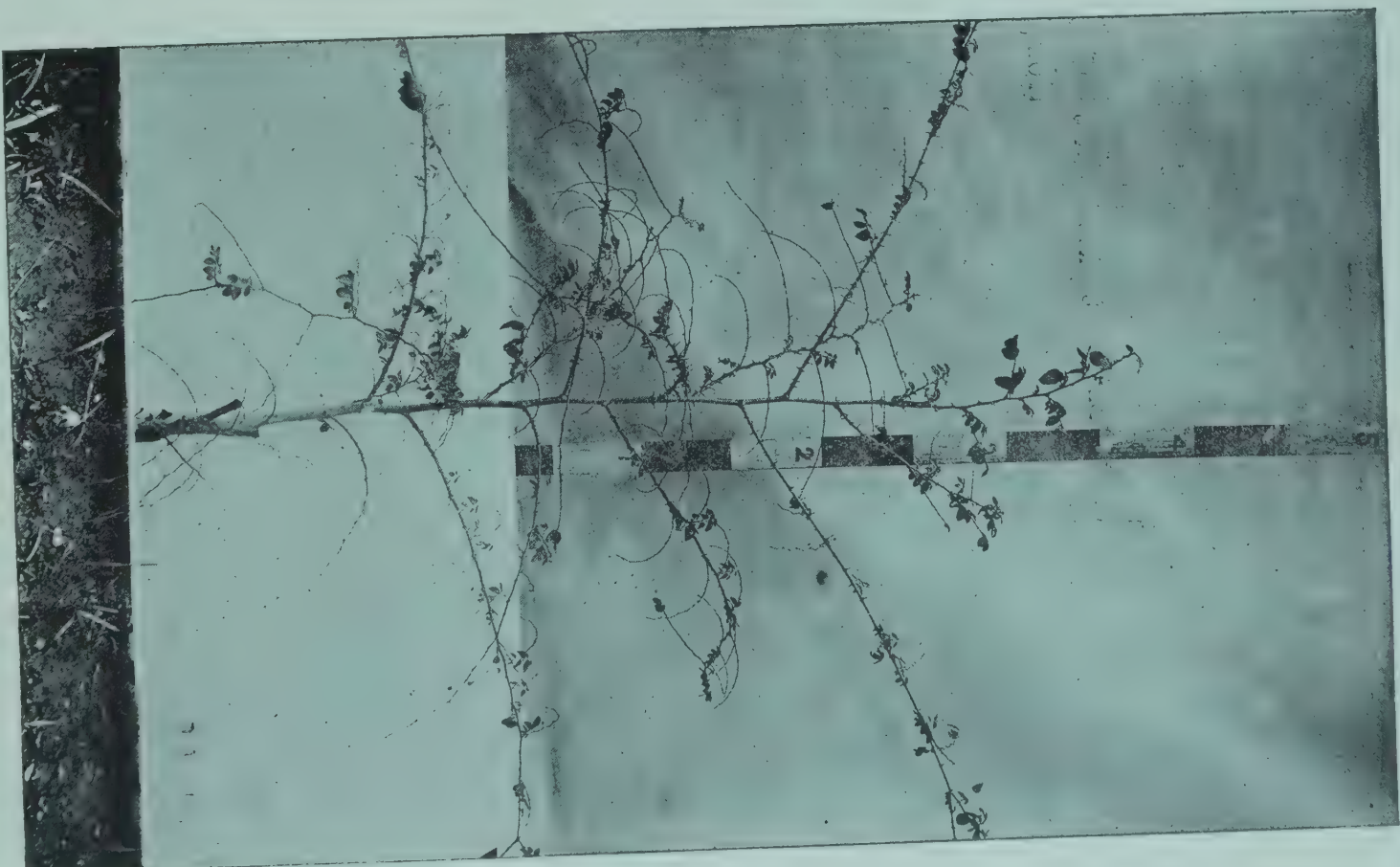
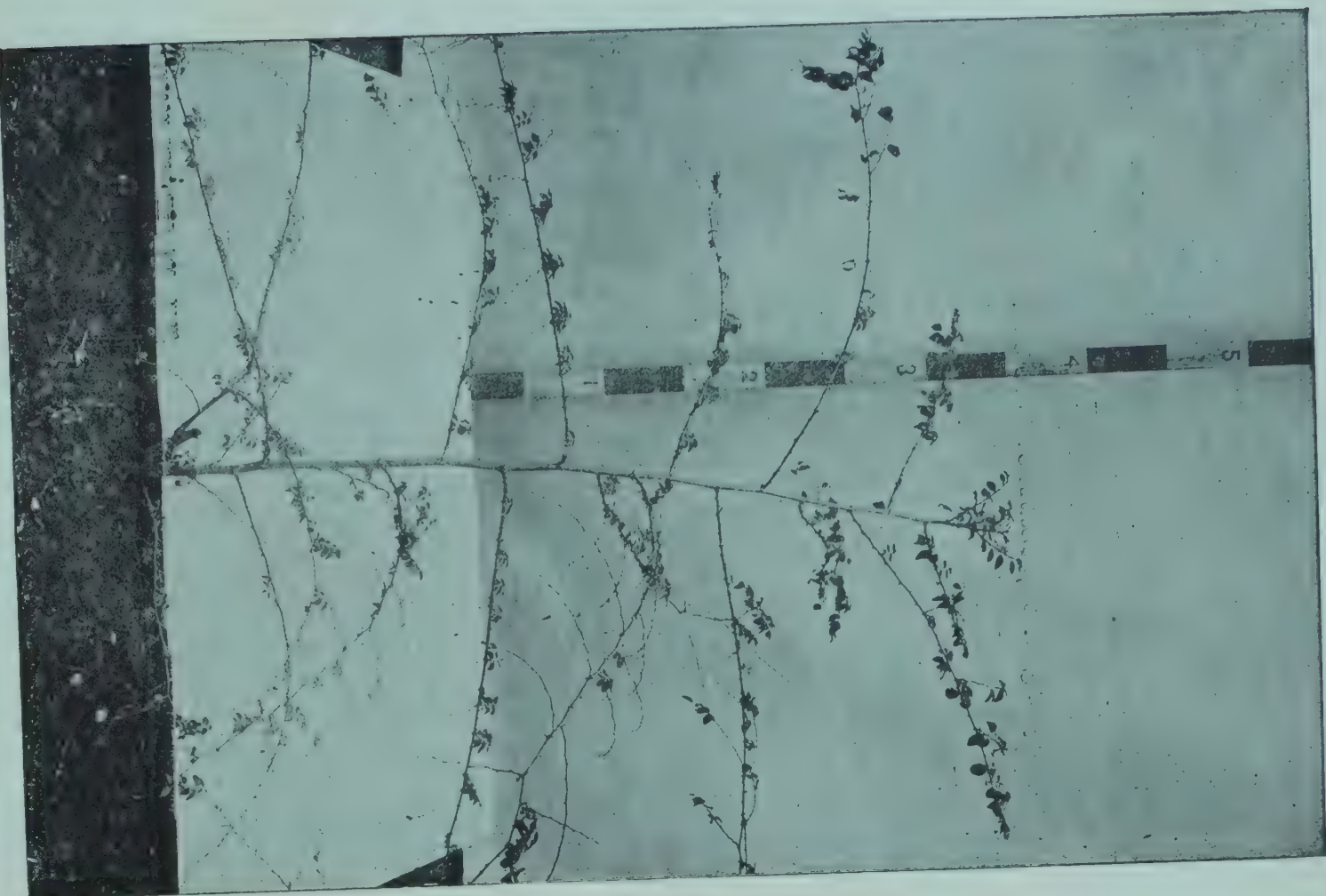


Photo-Mechl. Dept., Thomason College, Roorkee.

Plants of *Zizyphus Oenoplia* growing in Dehra Experimental Garden. Photographed in April 1918.
Note the extensive damage done to the lower branches and lateral twigs during the preceding rains
believed to be caused by a fungus, possibly a *Cladosporium*. The terminal shoot and ends of the

HOW THE SINDHI FISHERMEN CATCH LIVE MUGGERS.

BY D. G. OMMANNEY, DISTRICT SUPERINTENDENT OF POLICE.

Mr. D. G. Ommanney, District Superintendent of Police, Thar and Parker District in Sind, gives a most interesting account of how the Sindhi Fishermen catch live Muggers. He writes:—

"We went to the tank about 5 minutes from the bungalow and found that the men had spotted one mugger and tied it up, and that it was lying on the bottom of the tank. They also offered to show us how they caught the beast, provided they could find another one. Two men went into the water, one with a rope and the other holding a long stick with a blunt fish-spear at the end, swimming about on large water-pots specially made for fishing. It is said that the muggers fear the water-pots, and when they hear the men swimming about on them, lie quiet at the bottom of the tank. They looked about till they spotted a mugger, and one pressed the spear on his back and held it there, not wanting to wound the beast as that might have infuriated him and so reduced the chances of catching him. We saw the man holding the spear down, and then the second man dived under the water to slip the rope round the mugger by tickling him gently under the body to make him raise himself, and so allow the rope to be slipped round him. They then began to pull in the rope with the help of the onlookers on shore, and gradually a huge monster was hauled to the bank beside us. They stuck a stick into its mouth and tied it up, while it bellowed. Some of the men hung on to the rope to prevent it going back into the tank, while others pulled the first one caught to shore. This one was about 7 feet long and the other was about 9 feet."

MEETING OF THE BOARD OF FORESTRY.

We understand that the Board of Forestry which met in March 1916 will hold its fourth meeting in March 1919, and that a representative from each province will be invited to attend. The Board will discuss the programme of the Research Institute for the next three years as well as any forestry problems that may be referred to it for advice.

Any subjects proposed for discussion should reach the Inspector-General of Forests not later than 1st December 1918.

KING-EMPEROR'S BIRTHDAY HONOURS' LIST, 1918.

We are glad to see that the following members of the Forest Department figure in the recent Honours' List :—

Commander of the British Empire :—Archibald Alexander Dunbar-Brander, Esquire, Imperial Forest Service, Divisional Forest Officer, Nimar, Central Provinces.

Members of the British Empire :—Rao Bahadur Shrinivasalu Naidu, Divisional Forest Officer, Nagpur, Central Provinces, and Mr. M. Narsing Rao, Provincial Forest Service, Divisional Forest Officer, Bhandara, Central Provinces.

Rao Sahib :—M. R. Ry. Kodumudi Ramaswami Venkataramana Ayyar Avargal, Extra Deputy Conservator of Forests, in the Madras Presidency.

OBITUARY.

MR. ALEXANDER EDWARD ROSS.

We regret to record the death of Alexander Edward Ross, Imperial Forest Service, which took place at Maymyo, Upper Burma, on the 6th December 1917. He was the son of the late Lt.-General Sir A. G. Ross, K.C.B., Bengal Staff Corps, and was born in 1872 and passed into Woolwich. He found, however, that the work was not congenial and left Woolwich and entered for the Forest Service, passing into Coopers Hill in 1892. He arrived in Burma in December 1895 and spent the whole of his service there, beginning as an Assistant in Tharrawaddy. After serving for a few months in the Southern Shan States in 1897, he spent a long time in Tenasserim and made a Working Plan for the Thaungyin Forests. He served again in Tharrawaddy and returned for the last few years of his service to the Southern Shan States. He had not been in good health for some time before his death but carried on his work most energetically, and was a great lover of forest life and of Burma and he and his wife toured through many of the far distant forests of the Shan States. He was a very keen forest officer and was always ready with apt and often amusing comments on many aspects of forest work. He will be much missed.

CORRESPONDENCE.

FOREST JOURNALS.

SIR,

I expect your readers are getting rather fed up with the subject of forest journals, but it seems that we are no nearer a decision as to what they are and what they ought to contain than when the discussion started.

From Mr. Trevor's contribution on the subject in your March issue it would appear that the term 'forest journal' is capable of being applied to any record which individual D. F. O.'s may find it convenient to maintain for the purpose of supplementing standard records and returns. He describes the forest journal of the Kulu type as "a minute working-plan for each forest." Later it transpires that it also contains control forms. Now "Working Plan" and "Control Form" are perfectly definite and understood terms, and the only apparent reason why they should not be applied to the contents of the Kulu forest journal is that one must call something or other a forest journal in order to comply with the prescriptions of the Forest Code.

I fully agree with your irreverent correspondent 'Iconoclast' that unless the authorities are prepared to define with a greater degree of precision what the forest journal should contain, this record might just as well be scrapped altogether. In present circumstances it will, at the best, contain useful information which should properly be included in other records and, at the worst, uselessly repeat information available elsewhere.

MAILANI, DISTT. KHERI :

3rd May 1918.

J. N. OLIPHANT,

I. F. S.

DOMESTIC OCCURRENCES.

BIRTH.

GLOVER.—At Simla on June 2nd, 1918, the wife of H. M. Glover, Indian Forest Service, of a daughter.

INDIAN FORESTER

SEPTEMBER, 1918.

A NOTE ON THE ECONOMIC VALUE OF THE CHINESE TALLOW TREE (*SAPIUM SEBIFERUM*).

BY PURAN SINGH, F.C.S., CHEMICAL ADVISER TO THE FOREST RESEARCH
INSTITUTE, DEHRA DUN.

From the literature* on the subject of the Chinese tallow tree, it is evident that the idea of extending its cultivation in various localities in India, where it began thriving well, especially in the United Provinces and the Punjab, was given up, simply because the preliminary experiments on the extraction of fat and oil from the seeds indicated that the labour and expense involved in collecting seeds and extracting the tallow were far in excess of the value of the products. This has been rather unfortunate in view of the fact that in China the tree

* See *Agricultural Ledger* No. 2, 1904, which gives its habitat, introduction in India, the composition of the fats and the processes of its preparation from the seeds and an account of the experiments done in India to prepare the fat with negative results. See also Watt's *Commercial Products of India*. See also "Chemical Technology and Analysis of oils, fats and waxes" by Lewkowitsch, Vol. II, p. 70 and pp. 483—489.

is a source of some remunerative trade in Chinese tallow. It seemed to the writer that the preliminary experiments carried out in India, which have been quoted in different places, were not carried out properly and owing to the bad results obtained, the cultivation in India of a useful tree was wrongly given up. This note embodies the results obtained by the writer, which indicate that the question of the experimental cultivation of this tree is well worth re-consideration.

The fruits when dry open up and the white seeds can be easily beaten out by means of a wooden
 The yield of solid tallow. mallet. It was found that 20 green fruits weighed 30.795 grams, and the green upper covers amounted to 18.535 grams, the white seeds being 12.26 grams only; 100 grams of the white seeds when extracted with ether in a Soxhlet's Extraction Apparatus to remove all the white solid fat embedded in the upper white coating of the seed, gave 23.31 per cent. of fat. 100 grams of crushed seeds which had their inner kernels containing a drying oil all exposed to the action of the solvent gave, by ether, 43.51 per cent composed of fat and oil. The oil in the kernels, which is an excellent drying oil similar to linseed oil, for paints and varnishes, thus amounted to 20.20 per cent. Another lot of 3,000 grams of the uncrushed white seeds was extracted in the small extraction plant with petroleum benzine and 729 grams of the fat was obtained, the yield being 24.30 per cent.

The Chinese process of preparing the tallow as given by Dr. Porter* Smith is as follows:—

“The ripe nuts collected in mid-winter are bruised and the pericarp or shell separated by sifting. They
 The Chinese processes of the manufacture of tallow and oil. are then steamed in wooden cylinders with numerous holes at the bottom which fit upon kettles or boilers. The tallow is softened by this process and is separated from the albumen of the seeds by gently beating them with stone mallets when the tallow is effectually removed by sifting the mass with hot sieves. The tallow still contains the brown testa of the seeds which is separated by pouring it into a

* *Agricultural Ledger*, 1904, No. 2, page 13.

cylinder made up of straw rings laid one on top of the other in which it is put into a rude press and the tallow is squeezed through in a pure state."

The yield is about 8 per cent. Lewkowitsch gives a yield of 15 per cent. of tallow and 15 per cent. of the stillingia oil from the kernels.

The second is a more simple method adopted in some parts of China when the shells with coating of tallow and the kernels are bruised in a stone mortar and the mass is boiled for some time in water or steam is allowed to pass into it. The fat is thus brought to the surface where it floats and is removed as a cake when the water beneath has cooled to the ordinary temperature of the air.

It will be seen that both these methods, though followed in China, are wasteful in the extreme, recovering only a fraction of the total tallow. Neither of these processes is recommended for adoption in India, and it seems that the preliminary experiments that gave unremunerative results were mostly carried out on the Chinese lines. In a country where the tree occurs naturally in great abundance, as in China, it might pay to extract even a fraction of the fat, but it is difficult to make the same process succeed in India where the tree has to be cultivated at some expense.

The only process that would make the manufacture of vegetable tallow a remunerative industry in India is the extraction of the fat by such solvents as "Trichlorethylene" and petroleum benzine, etc. Modern Solvent Extraction Plants have now been perfected and not more than 5 per cent. of the solvent on 100 maunds of the seeds treated is lost in these plants and they are well adapted for the treatment of such materials as the seeds of *Vateria indica* or of the tallow tree.

For the preparation of the tallow, the whole seeds should be treated with the solvent, say, petroleum benzine, which would dissolve out of the white albuminous covering of the seeds, all the tallow contained therein. The solvent is then recovered and the

residual tallow freed from the last traces of petroleum benzine by blowing superheated steam into it.

For extracting the drying oil contained in the kernels, the seeds already treated with petroleum benzine are crushed and re-extracted with the solvent as before. The two products which, as is well known, differ in their chemical composition, are thus separated and obtained in the pure state.

The yield of tallow by this process is at least 50 per cent. more than that obtained by the crude Chinese methods and a similar quantity of drying oil is obtained as well, as a secondary product.

Owing to the absence of data as to the cost of creation and maintenance of plantations of this species it is impossible to give figures representing profit or loss resulting from the cultivation of this tree. It seems, however, probable that in spite of previous adverse reports the cultivation might be profitably undertaken provided up-to-date methods were adopted for obtaining the fat and oil from the seeds. It is after the figures of yield of seeds per acre come to hand that an exact idea of the profitable nature of the industry can be formed. It is a pity that no such data were worked out in connection with the preliminary and unsuccessful experiments referred to above. The following figures are quoted from Lewkowitsch :—"The tree commences to produce fruits at the age of four or five years and when it has reached its full development, it yields about 25—30 kilos of seeds per year."

The leaves of this tree are said to give a black dye in China.

A preliminary investigation carried out on the autumn leaves indicates that there is no dye-principle in the leaves, as is shown by the following analysis :—

	First lot fresh leaves, per cent.	Second lot leaves fresh but mostly red, per cent.
Moisture	48.84	53.14
Total solids or aqueous extract	12.88	19.76
Non-tanning matter	10.05	15.62
Tanning matter	2.83	4.14

The tan liquor gives no reaction with bromine water, but produced a dirty greenish precipitate with lime-water. Ferrous sulphate gives a blue-black precipitate and ferric chloride a greenish black precipitate. The leaves were then treated in different ways to detect the presence of any dye-principle of an organic nature but with negative results. It has been suggested that the *fresh* leaves might contain the dye reported to occur in the leaves and this will be investigated as soon as such leaves are available, but positive results are improbable.

When shade-dried leaves were treated with lime, they gave off ammonia. Ammonia was accordingly estimated in the leaves. The shade-dried leaves containing 13.66 per cent. of moisture gave 0.21 per cent. of ammonia.

Conclusion. The results of the enquiry may be summed up thus:—

- (1) That the cultivation of the tallow tree should be encouraged as a source of vegetable tallow and of the drying oil contained in the kernels of its seeds.
- (2) That the tallow and the oil must be manufactured with the aid of a solvent extraction plant and not by bruising the seeds and steaming them as in China, because the yield of the tallow by the latter process is at least 50 per cent. less than that obtained by the former.
- (3) That there is no dye-principle in the leaves worth extraction. The black dye, as produced by the Chinese, must be due to the action of iron mordants on the small quantity of tannin contained in the leaves.
- (4) The leaves should make an excellent manure, and it is recommended that manurial field experiments be tried with it.

IRRIGATED PLANTATIONS IN THE PUNJAB.

BY R. N. PARKER, I.F.S.

PART II.

(Part I appeared in the August issue of the "Indian Forester," 1918.)

The Chichawatni plantation consists of two blocks separated by an unirrigated strip. The planting of the eastern block has been nearly finished, but no sowing has yet been done in the western block. The completion of the eastern block has been delayed by shortage of water at the season it is required for sowings, and this in spite of the fact that the canal irrigating the block has a greater discharge per 1,000 acres irrigated than was originally intended, as a large area it was designed to irrigate will be left unplanted. Unless the irrigation arrangements are altered, it will probably be found impossible to plant up the whole of the western block, or to maintain it even if it were planted.

The Khanewal plantation is the one where shortage of water is likely to be most acute. At Khanewal itself the soil consists of a superficial layer 3 ft. thick, of sand mixed with finer particles in about equal proportions, below which is a pure and rather coarse sand down to the water-level some 60 ft. or more below the surface. The section exposed at Khanewal in wells under construction is probably a fair sample of the whole. When the alkali has been washed out by irrigation and the superficial layer of soil has been broken up by roots of trees, it is obvious that the soil will absorb far more than the $2\frac{1}{2}$ ft. of water allowed in irrigating Changa Manga. In Changa Manga, where the soil is stiff compared with Khanewal, strong winds in the hot weather do considerable damage to Shisham, especially when the soil is sodden after irrigation, and losses from windfall are likely to be much more serious in Khanewal.

The Tera plantation has been started to utilize a small supply of water which is available during the kharif in a distributary which irrigates land in the neighbourhood. Water will always be scarce and, for this reason, the plantation is being made with



Fig. 1.—*Dalbergia Sissoo*, 2 years old, unthinned, at Kot Lakhat, irrigated plantation, Punjab.



Photo. Mechl.-Dept., Thomason College, Roorkee.

Photo by E. Marsden.

Fig. 2.—*Dalbergia Sissoo*. Irrigated plantation at Kot Lakhat, Punjab, showing edge of alkali soil.
In the distance 2-year old and 3-year old crops divided by road.

trenches 15 ft. apart instead of 10 ft., and it is intended to keep the trenches open so that water can always be run along them instead of having to flood the whole area. The rainfall at Tera is about 20 inches against 15" at Changa Manga and about 8 at Khanewal, and the subsoil water is only 18 ft. below the surface so that the plantation will probably be successful in spite of the small supply of water.

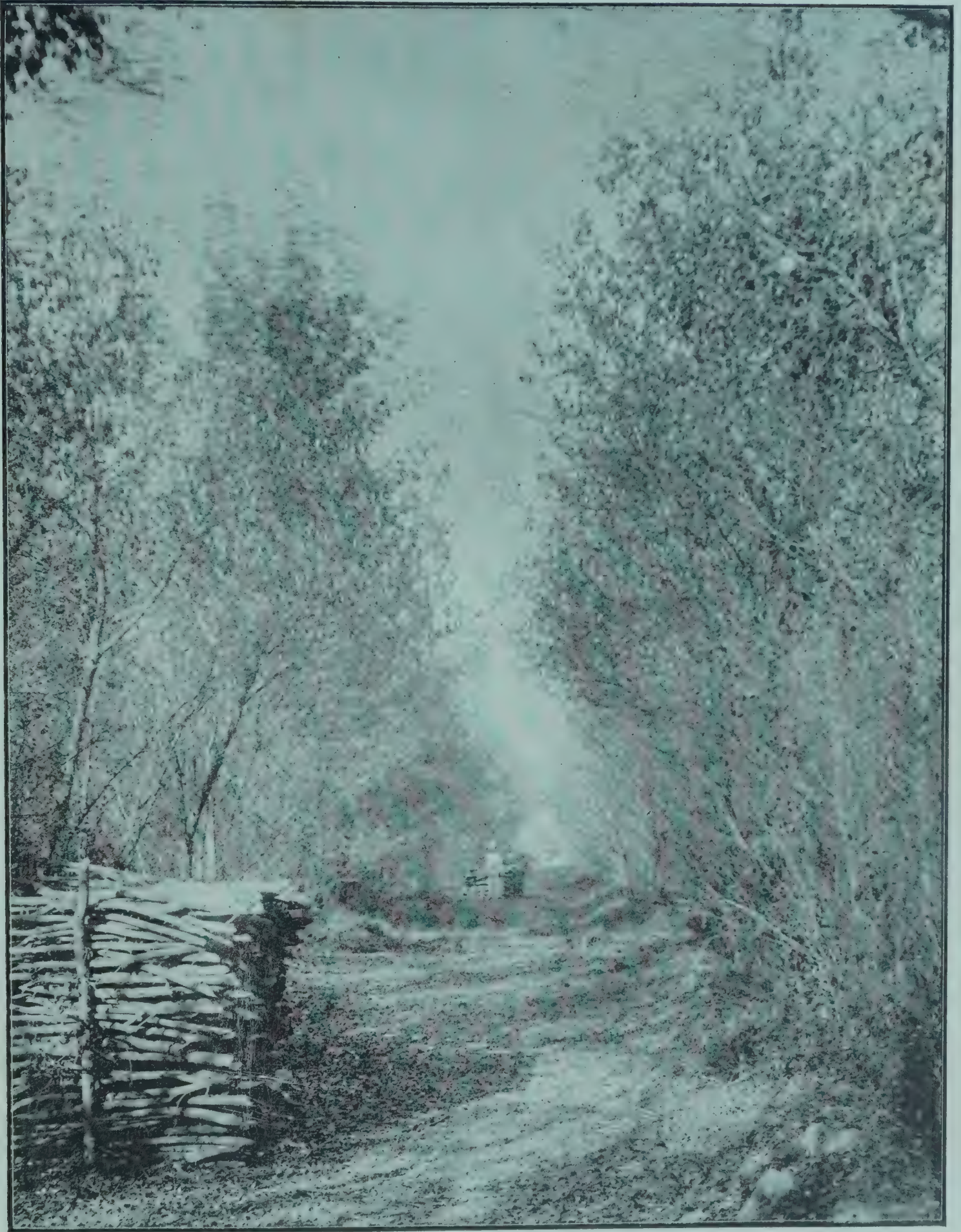
Kot Lakhpat plantation was started in 1911 when 400 acres were ploughed and sown. This system had been thoroughly tried at Changa Manga and was eventually given up, so that it is not surprising that some 50 years later it was found no more successful in Kot Lakhpat. It was tried again in 1912, 1913 and 1914 with uniformly bad results; but, in these years, at the same time, the system evolved at Changa Manga after much experimenting was also used. Under this method, trenches are made 1 ft. wide and 1 ft. deep at 10 ft. intervals, and running approximately parallel to the contour lines. The soil excavated is thrown in a ridge on one side of the trench. A small berm 3—4 inches wide is made between the trench and the ridge, and raised an inch or two above the natural level of the ground. Seed is sown on this berm and watered by percolation from the trench. Shisham germinates in about 15 days, and during this period the seed must be kept moist. This is done by filling the trenches up to the brim, and allowing a constant flow of water to run into them sufficient to make good the loss by percolation and evaporation. When the seed has germinated, the water is shut off and the trenches are allowed to become dry. Subsequent irrigations in the first year consist in running sufficient water into the trenches to moisten them from end to end. Early March is the best time for sowing, but in irrigated plantations water is seldom given before the end of March and then only for a few days, after which the canal may be closed for three weeks for annual repairs. As soon as the annual closure of the canal (if there is one) is over, sowings can start but, at this season, the bulk of the supply is probably wanted by the two and three years' old crops, and only water that can be spared after allowing for the irrigation of the whole of the

previous year's sowings can be used for extension of the plantation. In July especially if there has been rain, plenty of water is available for new sowings, but it is not advisable to sow after the end of July, as the seedlings will have only two months' growing season and will have to endure six months (15th October to 15th April) without water. Sowings, after the monsoon has started, are not nearly so successful as those done during the hot weather, as the vigorous growth of weeds is apt to suppress the seedlings. The best sowings in Kot Lakhpat were made in 1915, an exceptionally hot dry year with no rain worth mentioning.

The number of waterings received by Shisham in the first year depends on the time the seed was sown and on the soil. The earlier the sowing was done and the more alkali the soil contains, the more often water is required. The maximum number of waterings given in the first year may be taken at 7 and the average at 3—4. In the second year, two waterings are advisable, and in the following years only one is essential. This is for Kot Lakhpat where the rainfall is about 20 inches. Whether it will also be the case in Khanewal, with a sandy soil and a rainfall of 8 inches, remains to be seen. In Kot Lakhpat the subsoil water is about 18 ft. below the surface, so that no great harm beyond loss of increment has been done by not irrigating some portions of the plantation till quite late in the season.

The results on good soil are all that can be desired as the accompanying illustrations show. Plate 26, fig. 1, shows *Dalbergia Sissoo* seedlings two years old. Plate 27 shows a crop six years old, which has been thinned once and will need thinning again in 3 or 4 years' time.

In irrigated plantations where the capital cost is high and annual irrigation charges have to be met, the financial results are materially affected by the thinnings, partly owing to the intermediate money returns but mainly owing to the shortening of the rotation as a result of thinning. The best interval between the thinnings and the age at which they should start has not yet been ascertained nor has the rotation to be eventually adopted been fixed as yet. In Changa Manga, the rotation was originally



Photo, Mechl.-Dept., Thomason College, Roorkee.

Photo by E. Marsden.

Dalbergia Sissoo, 6 years old, just thinned, at Kot Lakhpur, irrigated plantation, Punjab.

15 years and has recently been raised to 20 years. It was found that without thinnings the longer rotation paid best ; but now that thinnings have been prescribed, it is probable that the advantages which a 20 years' rotation has over one of 15 years could be obtained with a rotation of 18 years. The first final felling in the new plantations will probably take place at the age of 15 years, and it will doubtless be found profitable to raise the age in the second rotation.

In Kot Lakhpat, thinnings have been tried at the age of 1, 2 and 5 years. At 5 years a thinning can be made, the yield of which will more than cover the cost, but at 1 or 2 years the produce cut is of no value, and thinning at such an early age is only justifiable if it benefits the crop. It has been found, however, that thinnings at one or two years are of practically no value as the stools of the plants cut coppice vigorously and, in a few months, the coppice shoots overtake the saplings, and a year later the crop looks as if it had not been touched. This would not happen if the thinning were made at the age of 3 or 4 years. A thinning at this age would certainly be unprofitable, but a second thinning could be made earlier than would be the case if the first thinning were made at 5 years. It is quite possible that it would be more profitable to make a thinning at 3 years old, at a loss, followed by thinnings at 7 and 11 years, and a final felling at 15 years, rather than to make the thinnings at 5 and 10 years and the final felling at 15 years. To settle this and similar points would take a whole rotation and the matter is complicated by scarcity of labour. It is clearly useless to prescribe more thinnings than can be carried out with the labour available, so for the present it is proposed to thin all crops at Kot Lakhpat when they reach the age of 5 years.

The cost of an irrigated plantation is high. In Kot Lakhpat, it costs Rs. 15-12-0 per acre for marking out and digging the trenches. Sowing costs Re. 1-14-0 per acre and 40 lbs. of Sissoo seed costing annas 8 is used per acre. Water charges amount to Rs. 2-12-0 per acre irrigated per annum, irrespective of the number of times water is given. In addition, there is the cost of the

establishment and coolies employed on irrigating, weeding, etc. The local coolie wage is 7 annas per diem.

Much difficulty has been experienced at Kot Lakhpat with bad soil. In a large portion of the plantation, the soil is heavily impregnated with alkali. The alkali, in addition to the injurious effect it has on plant growth, makes the soil very impervious to water. It occurs in irregular bands and patches interspersed with good soil and is always easily recognized by the vegetation which is different to that found on good soil. Sometimes areas are found in which the soil is not heavily impregnated with alkali but contains an appreciable amount. In these cases irrigation usually tends to cause the alkali to collect into patches, leaving the rest of the area free from alkali. In one plot, in Kot Lakhpat, this process has been watched. The plot was sown with *Sissoo* in the usual manner and the result appeared quite satisfactory, the lines of seedlings being complete. The growth of the seedlings was, however, slow and the plot seemed to be suffering from want of water, so it was watered from time to time out of its turn. Instead of improving, however, the plot as a whole became worse. Although in places the seedlings responded, in many parts they died and, in these places, a white efflorescence of salt appeared showing the cause of the death of the plants which had not previously been suspected. Now the plot consists of patches of good growth alternating with blanks.

Efforts have been made to stock bad soil by sowing other species than *Sissoo*, but they have all failed for the same reason that *Sissoo* fails. Under the system employed the seed is moistened by percolation from the trenches, but in alkali the water will not percolate. If the trenches are overfilled so that the water flows over the berm on which the seed has been sown, the soil gets caked and the seed rots. Even when the trenches are filled to the brim, the water does not percolate to the seed, and in alkali the sides of the trenches rapidly subside causing the seed to fall into the bottom of the trench where it rots in the water. In bad cases, after irrigating a plot of alkali and then allowing the trenches to dry, if one digs in the bottom of the trench one may

find that the soil has been moistened to a depth of 2—4 inches only and below this is quite dry and very hard in spite perhaps of water having stood in the trenches for a month before it finally dried up by evaporation. Consequently, on such soils, when germination has been obtained by rain or very careful watering, the seedlings remain stunted and can only be kept alive by much more frequent irrigation than it is possible to give.

There is no doubt that these patches of alkali will eventually disappear. Every time they are irrigated they improve somewhat and the water sinks in deeper. Certain plants come up with the irrigation, especially a grass—*Sporobolus arabicus*, Boiss., which is usually the first plant to appear and soon covers the soil. Plate 26, fig. 2, shows a patch of alkali. On the right of the picture the growth of the Sissoo is excellent and the sharp line dividing the good soil from the alkali, which is very characteristic, will be noticed. At the junction of the good and bad soil is a fringe of *kana* grass (*Saccharum Munja*, Roxb.) which owes its presence to the lateral light admitted to the good soil by the blank. This grass gives a good deal of trouble especially if owing to shortage of water or any other cause, the growth of the Sissoo is checked, as it soon overruns the whole area. At the same time if kept down by stubbing it out as soon as it appears, it is easily kept in check, and as soon as the Sissoo saplings begin to form a complete canopy, it is killed out as it cannot endure shade. The alkali patch shown in the picture has been densely covered with *Sporobolus arabicus* and contains scarcely anything else. When other grasses begin to appear it will be a sign that the soil has improved, and we shall then be able to re-sow Sissoo with every prospect of success, but *kana* grass is likely to give trouble as it rapidly overruns any blank unless the blank is due to alkali.

NOTES ON EUROPEAN FOREST RESEARCH.

BY S. HOWARD, I.F.S.

Talk of the appointment of provincial silviculturists is in the air. I spent a year in Europe in 1911-12, much of which was devoted to the silvicultural research then going on. Some three and a half months were spent working in the Prussian Research Institute and much of this article concerns Prussia but Prussia will serve as an example. Possibly some useful hints may be derived from it which may be of help in India.

In 1892 an International Forest Research Association was founded. This met at Mariabrunn, 1893, Braunschweig, 1896, Zurich, 1900, Mariabrunn, 1903, and in Belgium in 1910. I believe it also met in Petrograd in 1905 but I can find no record of this at the moment. Most European countries are members but France, I think, is not. If she is, she has taken no active part. The reason is not that France does not realize the value of the association but, so an eminent French forester informed me, if France were a member, the Association would sooner or later hold a sitting in Nancy, and if a party of Germans paraded the streets of Nancy there would certainly be trouble.

The events which led up to the formation of this association, as far as Germany is concerned, were as follows :—

Forest Research, in many instances, necessitates observations over long periods of time, longer than an individual man's working years, and over widely separated areas. Some institution is necessary, therefore, to direct methods for the sake of uniformity and to continue ideas despite the necessary changes in the Research Personnel.

Wedekind pointed this out as long ago as 1826, and in 1845 Carl Heyer issued a treatise concerning the foundation of an association to control research matters. About 1860 this was repeatedly advocated by Gustav Heyer, Baur, Gayer and Ebermayer to mention only some.

In 1867 Gayer sketched an organization for research institutes, and in 1868 Baur wrote an article on organization and the methods of conducting experiments.

The first real move made was at a meeting in Vienna in 1868 where a proposal was put forward to elect a committee of five who should—

- (1) prepare a scheme of Forest Research ;
- (2) draw up a list of the most pressing work ;
- (3) discuss the best method of organization ;
- (4) draw up rules.

The committee elected were Wessely, G. Heyer, Ebermayer, Judeich and Baur representing most of Germany. This committee wasted no time.

They met in Regensburg in November 1868. It was there decided that the larger states, Austria, Prussia and Bavaria, should have independent Research Institutes. For the smaller states the professors in the various forest colleges were to undertake research work as part of their duties. Among other things, they discussed the advisability of forming an association to further forest research and suggested an international association.

These proposals started a mass of controversy and finally in June 1870, as a result of an article by Danckelmann followed by a memorial to the Finance Minister, it was decided that forest research should be properly organized *but* the research institutes in all the states were to be combined with the educational branch. That is to say, the President of the Forest College was also to be President of the Research Institute.

As far as I can ascertain, Germany was the first country to organize its research and to found a Forest Research Association. The German Forest Research Association, although it really dates from the committee of five at Regensburg in 1868, was formally created in 1872. Germany has probably done more for Forest Research than any other European country and it was as a result of German activity that the International Forest Research Association was founded in 1892.

The usefulness of these International meetings cannot be over-estimated. For example, it was soon found essential to have some classification of thinnings, if results were to be comparable. The classification of thinnings, which I wrote in the *Indian Forester* in February 1916, was the Prussian classification adopted by the International Association in 1903 as nearly as it can be rendered in English.

FRENCH RESEARCH.

Instructions were issued in France in 1882 for organizing forest research. The research stations were to be under the control of the President of the Nancy Forest College. All experiments were to be proposed to the President and discussed by the President, Professors and Forest Officers attached to the college. An account of the experiment was to be compiled by the officer in charge of that branch and a record of the commencement of the experiment had to be sent to the "Directeur" of Forests. Every experiment was to receive a name and number and its progress was to be entered in a register which was to be always at the disposal of the college professors if they needed it. Any chemical analysis needed by the Forest Officer in charge of the experiments was to be made in the college laboratory. Reports of progress were to be submitted to the "Directeur" of Forests who was to order publication if necessary. A report of the work and the expenditure incurred was to be made yearly in January by the President of the College and sent to the "Directeur" of Forests. I regret that my notes do not make it clear whether the carrying out of the experiments was done by the college professors and officers or whether the local officers performed the work, but from what I saw in France I am inclined to think the college staff did the work.

The above was not a bad start but it was hopelessly carried out. Experiments were begun but were usually badly organized and badly performed. I see from my notes that there was an "experiment to study volume production in regular crops of Silver Fir—two experimental plots started in 1884 in the Dominale Forest of Rambervillers." Imagine it! Two plots for such an experiment and an article was written on the results in 1889!

It is a great pity France took no active part in the International Association. The hopeless inferiority of French Research is put down by French foresters to lack of men and money and bad organization. If France had attended the International meetings, enough interest would probably have been stimulated for men and money to be forthcoming and, at any rate, much would have been learnt about organizing research. Experiments ceased absolutely between 1896 and 1902. The last proposals I heard of in France were, that various departments of research should be inaugurated (undoubtedly founded in the Prussian departments) to be controlled by the "Directeur" of Forests or by some one chosen by him. The elements of an association were outlined with the "Directeur" as head, college professors who were interested, three conservators and two outside members, one a timber merchant and one a private forest proprietor. It was also decided that it would be better to have a special paper for research publications rather than that they should be published in various forest and agricultural journals as had been done in the past.

It was considered that the work proposed cost about £1,200 per annum. Considering the richness of French forest, this expenditure is nothing when it is remembered that Germany spends £6,000, Switzerland £2,000 and Sweden £880 roughly.

In 1911, however, these proposals had not materialized and a professor at Nancy informed me he was not very hopeful about them. He confessed that French Research was severely handicapped by not taking part in the International Association.

GERMAN RESEARCH.

The history of German Research has been already written above. In 1912 all German states of importance had their Forest Research Institutes (combined with the college) united under the German Forest Research Association (which meets as a rule twice a year), and this, in turn, united with the International Forest Association.

The Prussian Research Institute.—This will serve as an example of research organization in Germany. It was started in 1871, though not officially created till 1872, and it is united with the Forest College at Eberswalde. There are six branches :—

1. Sylvicultural branch.
2. Physical-chemistry branch.
3. Meteorology branch.
4. Plant physiology branch.
5. Zoology branch.
6. Mycology branch started in 1899.

The head of the sylvicultural, physical-chemistry and mycology branches are specially appointed men though they deliver certain lectures in the college. The heads of the other branches are the college professors of those subjects.

Besides the head-quarters at Eberswalde, there are numerous plots all over Prussia. The original orders were that the local forest officer should be in charge of the outstation experiment under the control of the "Regierungsforstbeamten" and directed by the Research Officer. This did not work. Pressure of other work, lack of technical knowledge and training in experimental work, and various other reasons all tended to show that the local forest officer is not the man to carry out the experiments, and although the original orders are still in force on paper, for more than 20 years all work connected with the plots has been done by the research staff.

In all branches researches are made over as wide an area as possible.

The President of the Research Institute must be in close touch with all work, and the experiments are all discussed by the German Forest Association.

The total expenditure of each branch is allotted by the President, but the actual details of spending the money are entirely controlled by the head of the branch in question.

It may be of interest to show briefly the kind of work done by each branch. This is not an exhaustive list but simply an indication.

1. *Sylvicultural branch*.—I know more about this than the others. When I was there, the staff consisted of Dr. Schwappach as head, with Assessor Rohrig (quite a junior officer) as assistant. Under them were two officers of the subordinate service. Local foresters assisted in the purely mechanical work of felling sample trees, in thinnings, etc., but not in marking them for felling.

The principal work of this branch is the compilation of yield tables and the collection of statistics connected with them.

During the summer months, the plots for that year were thinned by Schwappach, Rohrig, Jones or myself, not by the subordinate staff, and then measured and entered up by one of us, assisted by one of the subordinate research officers. The results were all worked out in Eberswalde during the winter. The curves were drawn by Schwappach himself, though a discussion was first held by the four of us as to its course. The plots extend throughout Prussia; I was working that summer near Posen.

Other work which this branch has taken up are:—relations between stacked and solid volume, experiments with exotics, experiments concerning root-formation, manure experiments, experiments on the technical properties of wood (with the technical and experimental station at Charlottenburg), seed tests, etc., etc.

It is worth noting that the tests of strength of wood, etc., are done by technical experts at Charlottenburg, and not by the Forest Research Institute, and that the sylviculturist represents the forest side of these experiments.

2. *Meteorology branch*.—This is especially concerned with experiments concerning the influence of forests on climate and not so much with the reverse. All sorts of observations on temperature, humidity, winds, etc., are made.

3. *Plant physiology branch*.—This is purely botanical. It takes up such subjects as researches on iron bacteria, formation of annual rings, grass floras, influence of the district on seeds, influence of soil factors on plants, natural distribution of forest trees, etc.

4. *Zoology branch*.—Concerned with zoological researches, as far as they concern forests, and with control methods.

5. *Physical-chemistry branch*.—Concerned with the chemistry of soils, humus formation, pan formation, etc., etc.

6. *Mycology branch*.—Purely concerned with mycology in its relation to forestry and control methods.

A FEW REMARKS.

Judging from European experience, it appears that each province should conduct its own researches. The provincial silviculturists will be the first step towards a proper research staff in the various provinces in India. Beyond this point, however, decentralization is a mistake. The methods and ideas must be controlled by a central body, if any unity is to be obtained. Thus the various experiments in each German state are carefully discussed, and an exact procedure and method is passed by the German Forest Research Association before the experiment is started. Not only does this make for scientific method, but it prevents unnecessary repetition of work. Whether a central research institute at Dehra Dun will be necessary once the provincial institutes are begun is an open question.

The writer thinks it is unnecessary, but *some* central board of control is absolutely necessary; and, for the present, the Dehra Dun Institute, combined with the Board of Forestry, takes the place of a Forest Association.

India should certainly become a member of the International Forest Research Association. Even if no Indian forester ever attended the meetings, the society's proceedings would greatly benefit Indian Forest Research. A few years ago, suggestions of introducing European methods into India were often greeted with the remark that "Indian conditions" rendered European methods impossible. It is about time this ghost was laid. Local conditions certainly influence all work, but they influence *details* far more than *principles*.

In Indian Research work (I speak of silvicultural research and the collection of statistics) mistakes have been made which

are merely a repetition of mistakes made formerly in Europe but which have been solved now and the European solution is often directly applicable to India. If the Forest Research Institute had been from the start a member of the International Research Association, many of these mistakes could have been avoided, to some extent at any rate. I imagine the Association is defunct at present, but there is no doubt it will be revived after the war.

SYLVICULTURE IN THE CENTRAL PROVINCES FROM THE TAX-PAYER'S POINT OF VIEW.

BY THE HON'BLE J. W. BEST, I.F.S.

During the last three years the gross annual revenue from Government forests in the Central Provinces has risen from Rs. 28,90,062 to Rs. 34,10,595, and this increase has been mainly obtained by the more intense working of our annual coupes and by the improved timber market. In the year 1916-17 the net income which the Central Provinces tax-payers gained from their forests' property was Rs. 16,19,913 compared with Rs. 10,20,490 in the five years previous to 1915-16. It is true that in the United Provinces a similar satisfactory increase of revenue has occurred and the *Pioneer*, in its leading article of April 4th, shows a just appreciation of this, but I think is hardly justified in its somewhat pharisaical remark that "we may hope that the time is not far distant when other Local Governments will come into line with that of the United Provinces, and deal with their forests in the same generous spirit investing in them the money so badly needed for their development." Our record is not so bad, although our staff has been much reduced by a number of officers being permitted to join the I. A. R. O., considerably more so than is the case in the United Provinces. I believe I am correct in stating that it was in the year 1910-11 that Mr. Hart, then Chief Conservator in the Central Provinces, pointed out to the Local Government the necessity for the construction of a system of good fair-weather roads for the proper exploitation of the capital lying idle in the hitherto almost inaccessible forest products of the

province, more particularly of timber. This resulted in a five years' road programme being sanctioned, and the prospects of funds being provided to carry it out.

As an illustration of the results of the sound investment of capital in forest communications, I quote the following case:—

In the seven years up to the year 1910-11, the average expenditure on roads in the Rahatgaon and Magardha Ranges of Hoshangabad Division was Rs. 204. This was merely sufficient to keep the existing tracks in repair.

The total gross revenue from the timber and firewood of the forests in this period was Rs. 93,751. From the year 1911-12 to the present time a sum of Rs. 18,310 has been expended on the construction of roads, during which period the gross revenue from timber and firewood has been Rs. 2,78,951 and so far in the year 1917-18 it is Rs. 1,12,550.

Of course it cannot be said that this large increase is *entirely* due to the money spent on roads. Yet, doubtless, if the money had not been so spent, the increase in revenue could not have taken place.

A return of Rs. 1,85,200 for an expenditure of Rs. 18,310 in seven years cannot be said to be a bad investment.

A road system is, however, only a means to an end in making possible the sale of produce hitherto unsaleable. What we have to ask ourselves is whether, now that communications are open, the Central Provinces tax-payer is getting the most profitable rate of interest on his forest capital of tree growth. In other words, have we any real idea of what the financial rotation of our Central Provinces forests is? We have no Research Institute and are not so happily placed as the United Provinces in this way, but this should not mean that where it is possible no efforts should be made to ascertain the financial rotation of the different kinds of forests in each forest division. Roughly, the tree forests of the Central Provinces can be divided into two main groups as regards their silvicultural treatment. The more remote forests and those which are likely to produce large timber are being treated under what are vaguely termed "Improvement Fellings." This

may mean anything but, in most cases, involves selection fellings and cleanings combined. Where there is a demand for small poles and for firewood, or where there is little likelihood of large timber being grown, the forests are treated under the coppice-with-standards system of felling, although this treatment is, in some cases, called "Improvement Fellings." The first so-called improvement fellings generally apply to Sal and teak forests.

Owing to the absence of annual rings, it is not possible to ascertain the rate of growth of Sal except by the formation and periodic examination of sample plots. The difficulty with sample plots is that, owing to the frequent transfers of officers, they are sometimes forgotten. This branch of research was recently taken up by the Sylviculturist and I believe that the results of his investigations were not very flattering to the capacity for growth of our local Sal.

In the case of teak, however, we have, in the annual rings which can be counted when coupes are felled, ample means of ascertaining the rate of growth and so forming some idea of the financial rotation.

When I took over charge of the Hoshangabad Division in the year 1914 I had, as I now realize, too conservative views on the danger of over-cutting in teak coupes under the so-called improvement fellings. After discussing this question with my Conservator, I set myself out by collecting statistics to prove that he was wrong with the result that I have successfully proved that he was right. With the help of Mr. George, I.F.S., and Mr. McDonald, P.F.S., the girth and height-growth of over 4,000 felled teak trees were recorded; and after dividing the results into two classes, two useful curves of mean growth were obtained. In addition, I have collected, for over two seasons, information from market reports of the relative value of logs according to their girths. After deducting the cost of cutting, extraction and maintenance and by ascertaining the measurements of a large number of trees, I have been able to get some idea of the financial rotation for teak in the two classes into which I have divided it. In Hoshangabad the demand comes from Hyderabad, Khandesh,

Indore and up-country for teak wood, and the length which has been found most suitable for transporting to the market and to meet the demand, is of thirteen feet. This standard length is remarkably constant, and when a felled tree is cut up by a coupe lessee, he aims at getting as many as possible of the standard thirteen feet logs. I have, therefore, calculated the value of the tree at its various ages from the number and girth of the standard logs which records show that it may be expected to yield. When a coupe is near the market, a demand arises for smaller logs and firewood. The values of these, however, are slight compared with the values of the standard logs, and I have not taken them into consideration in the preparation of the tables, but this must be remembered when considering the values in column II of the table shown below as well as the fact that the trees measured were those felled under the improvement fellings system and represent a rate of growth lower than that which we can expect in the future from improved methods of conservancy. The cost of maintenance shown in columns 6 and 10 is low and the calculation was made as follows :—

More than half the revenue of the division comes from timber and firewood, and $\frac{9}{10}$ ths of the revenue from timber and firewood is derived from teak wood. It is fair, therefore, to put half the cost of the annual expenditure to the maintenance of teak trees. This amounts to Rs. 50,865 per annum. If we multiply the average number of teak trees felled each year by the number of years which we know from columns 1, 2, and 3 it takes for a tree to reach maturity, we get the figures 1,11,04,145 which very roughly represents our stock of trees on which the Rs. 50,865 per annum is expended. Thus the cost of looking after one tree per annum is '0073 annas. This calculation is probably unsound mathematically but is, I think, good enough to work on. I can think of no other way of calculating it. It will be seen that trees with a maximum height-growth of over 50 ft. after 40 years' growth come into the first class while those below are relegated to the second class.

Taking the table for first class teak: If only one standard log is grown per tree, then the figures in columns 7 and 8 show

that it would not pay the tax-payer to grow his trees beyond a 20 years' rotation because from the year 20 to the year 25 the value of the tree increases from Re. 1-2-0 to only Re. 1-3-0 whereas the sum of Re. 1-2-0 (value at 20 years) if put out at 4 per cent. compound interest would in the same period of five years be worth Re. 1-6-0.

Therefore, under these circumstances, it would be better to cut the tree at age 20, put the money in some other investment and grow another tree. The above conditions are, however, not natural as the figures from collected data in columns 11 and 12 show that more than one standard log can be expected from most trees. In the case of a first class tree, columns 11 and 12 show that mathematically it does not pay the tax-payer to grow a tree beyond 35 years. After 30 years' growth, a first class teak tree is worth Rs. 2-1-0; and after 35 years, Rs. 2-7-6 compared with Rs. 2-1-0 plus compound interest in the same period which comes to Rs. 2-8-0. If the tree is felled at 35 years and another grown in its place, then, after a second rotation of 35 years, the tax-payer will get Rs. 2-8-0

			Rs.	a.	p.
plus compound interest for 35 years	...	...	9	12	0
plus one teak tree, 35 years old	...	...	2	7	6
			<hr/>		
Total	...	...	12	3	6

compared with Rs. 7-6-0 if the first tree is allowed to grow for a further 35 years instead of being felled and its value put out to interest.

Similarly as regards the second class trees shown in the second table, the mathematical financial rotation would be 35 years when the tree is worth about Re. 1-7-0. By investing this amount the tax-payer after the second 35 years could get—

			Rs.	a.	p.
Re. 1-7-0 plus compound interest	..	...	5	10	0
One teak tree, 35 years old	...	...	1	7	0
			<hr/>		
Total	...	...	7	1	0

compared with Rs. 2-11-6 if he had allowed the tree to go on growing for the full 70 years.

By continuing to grow a tree up to 70 years, the Government thus loses, in the case of first class trees, Rs. 4-13-6 per tree, and, in the case of second class tree, Rs. 4-5-6. This is the case of *one tree only*; but to appreciate what this means to the tax-payer, the figures have to be multiplied by a good many thousand trees. The mathematical financial rotation would, in some cases, probably be a little shorter, say 30 to 32 years, as I have not taken into account the value of firewood and small pieces which can only find a local market in the few felling-series which are close to the demand.

As is well known, the financial rotation is not the sole consideration when determining the age at which trees should be felled, but should be the main factor in fixing it. Such considerations as a limited but urgent demand for the production of some large timber, climatic considerations, local industries, possible changes in the sizes required owing to improved conditions of house-building, communications, etc., and the danger of flooding the market with too large a supply of one particular size of produce all require careful thought.

The timber is required for house-building, and I see little likelihood of any radical change in the size of houses and the requirements of timber for them during the next hundred years in this country. To be on the safe side, it would be sound policy to grow the few first class teak forests, which we have, on a 60 years' rotation from which we could expect four feet girth logs, and to treat the second class (the majority) under the coppice system with a rotation of 30 years. Where there is danger of frost, it may be necessary to maintain the few first class trees as standards in the interests of the coppice.

I cannot claim that my figures would be applicable to the rest of the province but think that they may be, and that the collection of similar data in other forest divisions would give Government some most useful information.

As regards the forests already under the coppice-with-standards system, whether teak or otherwise, there are now in many divisions, more particularly the Nagpur, Wardha and Bhandara divisions, many square miles of coppice shoots, *of known age*

varying from age one year to nearly thirty years, from which it would be possible to collect most accurate figures of the rate of growth of most of the species now being coppiced in the Central Provinces. Hitherto, in coppice, we have blindly worked on the basis of a thirty years' rotation giving as our reasons for this, in working-plans, the fact that we had no data for calculating the correct rotation, and that thirty years seemed a suitable period. Such haphazard methods were the only possible way until recently. Now that we have the means of ascertaining the financial rotation from actual coppice growth, it is up to us to find out whether the tax-payer's forest capital is laid out in the most profitable manner in view of local and special conditions.

I wish to acknowledge with thanks the help given me in working out my curves by Mr. Marsden, the Sylviculturist, and more particularly by Mr. Howard, I.F.S., of the United Provinces.

Hoshangabad Division, C. P., teak, first class.

Age.	Height in feet.	Height in inches at 4 1/2' from the ground.	CALCULATION ON THE ASSUMPTION THAT THE TREE CONTAINS A LOG OR POLE 13' LONG.					CALCULATIONS FROM MEASUREMENTS OF FELLED TREES.					REMARKS.
			Average market price of one 13' log, allowing for squaring.	Cost of cutting, carting, etc., 13' log.	Cost of maintenance of one tree, annas and pies.	Nett value, i.e., cost 4 - (5+6).	Previous value plus compound interest @ 4%.	Tree value after deducting expenses before arrival in market.	Cost of maintenance, annas, annas.	Rs. a. p.	Nett value of tree.	Previous value plus compound interest @ 4%.	
1	2	3	4	5	6	7	8	9	10	Rs. a. p.	Rs. a. p.	Rs. a. p.	13
5	14	7	0 8	0 6	...	0 4	...	0 4	...	...	...	...
10	21	13	1 14	0 6	...	0 14	0 5	0 14	...	...	0 14	...	
15	27	17	1 9	0 7	...	1 2	1 1	1 3	...	...	1 3	...	
20	33	21	1 12	0 9	...	1 3	1 6	1 10	...	...	1 10	...	
25	38	25	2 0	0 12	...	1 4	...	2 1	...	...	2 1	...	
30	43	30	2 4	0 14	...	1 6	...	2 8	...	...	2 7	...	
35	47	33	3 0	0 15	0 6	1 10	2 7	2 14	0 6	0 6	2 13	...	
40	50	37	3 0	0 15	0 7	1 10	...	3 6	0 7	0 7	3 5	...	
45	53	40	5 0	0 15	0 8	2 15	...	4 0	0 8	0 9	4 12	...	
50	56	45	9 0	0 20	0 13	6 14	...	4 14	0 9	1 3	5 12	...	
55	58	47	10 0	0 20	0 20	9 14	...	5 14	0 2	2 0	5 14	...	
60	60	50	13 0	0 20	0 21	11 13	...	6 0	0 2	1 1	7 6	...	
65	62	52	15 0	0 20	0 22	14 3	...	7 8	0 3	7 4	8 5	...	
70	62	54	17 8	0 20	0 27	15 7	...	8 8	0 4	4 1	9 9	...	
75	62	55	19 0	0 20	0 34	16 0	...	9 14	0 5	5 4	10 1	...	
80	62	56	20 0	0 20	0 44	15 15	...	10 8	0 6	6 10	...	...
85	62	56	20 0	3 12	0 10	...	...	...	...	...	...	...
90	62	56	...	...	...	...	...	...	...	...	...	...
95	62	56	...	...	...	...	...	...	...	...	...	...
100	62	56	...	...	...	...	...	...	...	...	...	...

* Rs. 2-8-0 for 35 years, at compound interest.

Hoshangabad Division, C. P., teak, second class.

CALCULATIONS FROM MEASUREMENTS OF FELLED TREES.							
Age.	Height in feet.	Height in inches at 4½'	Tree value after deducting expenses before arrival in market.	Cost of maintenance, annas.	Nett value of tree.	Previous value plus compound interest @ 4%.	REMARKS.
1	2	3	4	5	6	7	8
5	11	3	...	...	...	...
10	18	6	...	...	...	...
15	22	9	...	...	...	...
20	26	11	0 8 0	...	0 8 0	...	
25	29	15	0 15 0	...	0 15 0	0 9 8	
30	32	17	1 3 0	...	1 3 0	1 2 0	
35	34	20	1 8 0	0 6	1 7 6	1 7 0	
40	36	22	1 9 0	0 7	1 8 0	1 12 6	
45	38	25	1 11 0	0 8	1 10 0	...	
50	40	27	2 0 0	0 9	1 15 0	...	
55	42	30	2 3 0	0 1	2 2 0	...	
60	44	32	2 8 0	0 2	2 6 0	...	
65	45	34	2 11 0	0 2	2 9 0	...	
70	47	35	2 14 0	0 2	2 11 0	5 10 0*	* Re. 1-7-0 plus compound interest for 35 years.
75	48	37	3 1 0	0 3	2 14 0	...	
80	48	38	3 2 0	0 4	2 14 0	...	
85	49	39	3 4 0	0 5	2 15 0	...	
90	49	39	3 6 0	0 6	2 15 0	...	

MANUFACTURE OF MATCHES IN RANGOON.

BY A. J. BUTTERWICK, P.F.S.

At the end of 1911 and the beginning of 1912, the writer was placed on special duty to mark timber for the match factory of Messrs. Lim Soo Hean & Co., Rangoon, in the Mahuya and Paunglin Reserves, Hlegu Range, which, at that time, was a portion of the Pegu Forest Division. The match industry in Rangoon was then in its infancy, and it was not known for certain at that time what timbers were suitable for it or not. According to orders received, the writer marked the following species for the match firm :—

1. Letpan (*Bombax malabaricum*).
2. Didu („ *insigne*).
3. Thitpok (*Tetrameles nudiflora*).
4. Setkadone (*Trewia* „).
5. Tein (*Stephegyne parvifolia*).
6. Taung thin baw (probably a species of *Sterculia*).
7. Ma-u (*Anthocephalus Cadamba*).
8. Odein (*Ehretia laevis*).
9. Shawbyu (*Sterculia fætida*).
10. Hmondaing (*Kokoona littoralis*).
11. Taungmeok (*Alstonia scholaris*).
12. Budalet (*Elæocarpus lacunosus*).
13. Gwe (*Spondias mangifera*).
14. Thayet (*Mangifera indica*).

The above particular kinds were very probably selected as an experimental measure, as their timber was lightish in colour, and the logs floated easily even when green. The habitat of almost all of them was the damp evergreen forests, which are so commonly found covering the alluvial land along streams, and which are annually inundated during the rains. One of the predominating species of these forests is a kind of cane called danon or zanon (*Calamus arborescens*). The logs obtained from the above-mentioned trees were floated down to Rangoon by way

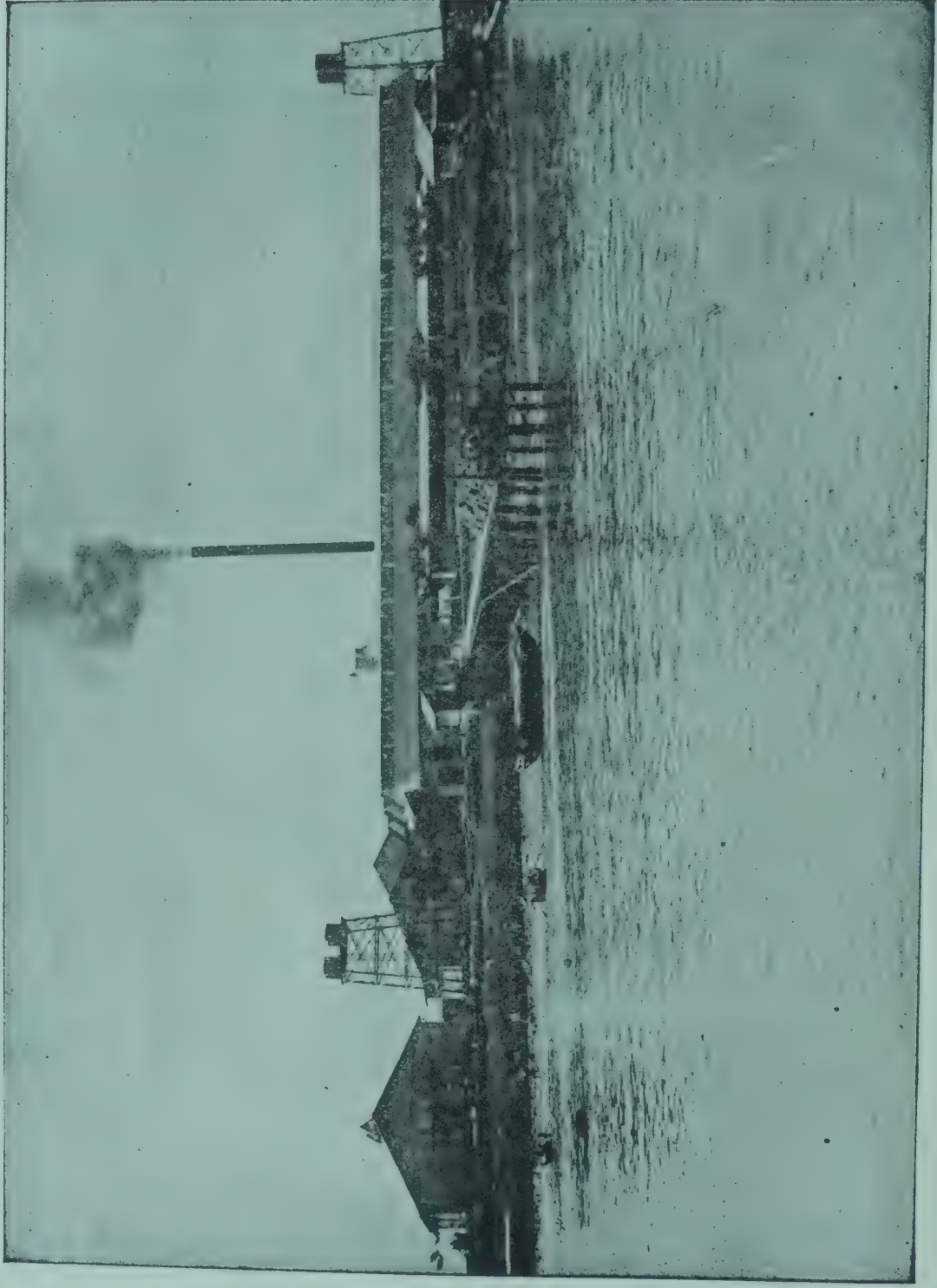


Photo. Mechl.-Dept., Thomason College, Roorkee.

Match Factory of Messrs. Lim Soo Hean & Co., Rangoon.

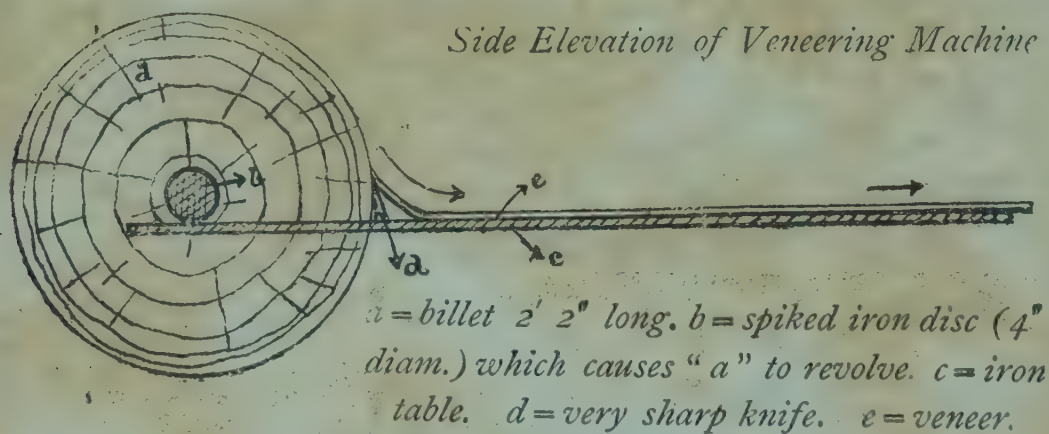
of the Mahuya and Paunglin Chaungs, which in conjunction formed the well-known Pazundaung Creek.

2. At that time, the writer was very keen to visit the match factory in Rangoon and see which timber was found suitable for the industry and which unsuitable. As he was shortly after transferred from the Pegu Division to the Forest School, Pyinmana, opportunity did not offer for some time. In December 1917, however, when on tour with the students of the Forest School, a visit to the Rangoon match factory was one of the items of the itinerary. The proprietors, Messrs. Lim Soo Hean & Co., not only allowed the School to see their match factory at work, but also very kindly deputed one of their representatives to explain to the students all the different stages in the manufacture. From that visit and also from a subsequent letter from the firm, the following notes have been compiled. The writer is much indebted, therefore, to Messrs. Lim Soo Hean & Co., Rangoon, for all the help given, and ventures to publish herewith the information obtained from them in the hope that it may be of some interest to the readers of the *Indian Forester*. The photo of the match factory published herewith (Plate 28) was also obtained from the managing firm.

3. The factory is situated on the right bank of the Rangoon river, 6 miles below the capital, near a village called Kanaung. As far as it was gathered, the site was chosen for no other reason but that Messrs. Lim Soo Hean & Co had a rice factory there originally, and it was thought that the machinery of both could be worked by one superior Engineering staff. Besides this, the site was very convenient for a match factory being close to Rangoon and right on the banks of the river. The factory was opened in 1909. The only timbers which are at present in use in it are Letpan (*Bombax malabaricum*) and Shawbyu (*Sterculia fætida*). The former is used for the box-covers and for the sides of the drawers, the latter for the splints and for the bottoms of the drawers. Messrs. Lim Soo Hean & Co. have found all other woods a failure for one reason or other. Even the Shan States pine (*Pinus Khasya*) has been tried; but it too was found to be unsuitable as the knots in the wood chipped the sharp keen edges

of the peeling knives in their machines, and the exuding resin clogged their machinery. The Letpan and Shawbyu logs are at present obtained chiefly from the Shwegyin Division on the Sittang river; Government duty costs the firm Rs. 2 a ton and carriage from Shwegyin to Rangoon *via* the Pegu-Sittang Canal Rs. 13 a ton.

4. The following essentials are required in the Letpan and Shawbyu logs. They must be green and as cylindrical as possible. Also the timber must not be spongy and brittle like cork, as this causes the veneers to break off during the peeling. Logs ranging in girth from 4' 6" to 9' (without bark) are most in demand. Each log is dragged up a slipway from a small inlet from the river. The bark is then removed by hammering and hand-peeling. This bark is useless for cordage, as salt water has thoroughly soaked into it and ruined its usefulness. After the bark has been torn off, the logs are cut up into lengths of 2' 2" by a straight cross-cut saw worked by a small machine. Each 2' 2" piece is then placed on to the veneering or peeling machine, a rough drawing of which is given below.



The log is revolved round at a great speed towards the table, which is about 12' long, and, at the same time, the knife keeps eating into it, advancing very gradually according to requirements. Thin sheets of wood varying in thickness from $\frac{1}{100}$ " to $\frac{1}{16}$ " are, therefore, rolled on to the table and helped on by men standing along the sides. At the commencement, the first 2 or 3 sheets are

broken and non-continuous, as the logs are very seldom cylindrical. These are rejected until continuous sheets of wood are obtained. In a very short time the log is whittled down to a cylinder about 4" in diameter. This is rejected as the wood near the pith is considered too spongy and brittle for veneers. There are altogether five such veneering machines, one for the splints, one for the bottoms of the drawers, one for the sides of the drawers and two for the box-covers. The first two kinds use Shawbyu timber and the next three Letpan. The machine, which peels the logs for the splints, divides at the same time the wooden sheets into halves; each half, therefore, being about 1' 1" broad. The machine for the bottom of the drawers at the time of peeling also divides the sheet into 11 portions, each being $2\frac{1}{4}$ " broad. There is, accordingly, a small wastage of about an inch here. The machine for the sides of the drawers at the time of peeling, not only severs the sheets into three portions, each being about $8\frac{1}{2}$ " broad, but also scratches on each portion lines to mark off the places where the folding will afterwards be done when the drawers are finally made. Similarly, the machines for the box-covers at the time of peeling not only sever the sheets into five strips, each of 5" width, but also scratch on each strip the places for the subsequent folding.

5. From the peeling or veneering machines, the strips are then taken to the cutting or slicing machines. Here they are placed tightly packed one over another into a chamber about 7" to 10" high. Each of these machines has a kind of sharp guillotine knife fixed in a frame, which works up and down rapidly. As it goes sliding up and down, the compressed bundle of veneer strips is forced out to the required distance and is neatly sliced off. For the splints this distance is minute and is just enough to get them cut square; for the bottoms of the drawers it is 1", for the sides of drawers $\frac{5}{8}$ ", and for the box-covers $2\frac{1}{4}$ ". In the case of splints, the cutting machine has also attached to the inner side of the guillotine knife, and placed at right angles to it, five minute knives situated at equal distances apart from one another. At the same time, therefore, as the former slices through the compressed bundle of veneer sheets, the latter neatly sever the cut portions

into six rows of splints about 2" long. It is believed that this machine needs the most careful attention, for if it is not adjusted properly, the splints will not be cut square. To give an idea of how fast these machines work, if we take the sheet for the splints as $\frac{1}{12}$ of an inch thick, and the space in the chamber into which the sheets are compressed as 7", it will be seen that about 84 sheets are worked on at a time by the slicing machine. The little knives mentioned above divide these into six portions for the splints. Therefore each time the guillotine works $84 \times 6 = 504$ splints are cut. The time taken by the knife to go up and down was not more than 4 seconds. So that in one minute one machine cuts about $504 \times 15 = 7,560$ splints.

6. These splints are then gathered up in baskets and taken to the drying rooms. Here they are placed in huge cylindrical drums (7' long \times 3' 8" diameter) with perforated walls. These are then railed into chambers heated by steam pipes, and during the heating, they are slowly revolved round and round. This is done for five hours, and it is said that by the end of that time the splints are thoroughly dried, cleaned and polished. From this drying chamber they are then taken and placed into a sorting machine, which, by a shaking movement through a gauged sieve, rejects the broken bits. The splints are then neatly arranged in iron trays 20" \times 14" \times 2" and taken to the machines which provide them with their head composition.

7. There are five such continuous machines, and the ingenuity of their mechanism is absolutely bewildering and wonderful. The splints are gathered directly from the iron trays into a receptacle in the middle of the front of each of the machines. By a shaking movement, the splints are passed breadthwise from the said receptacle into the grooves of a sort of grill below it. The front ends of the splints lying in the grooves project a little over the edge of the table, and whilst a pressure rail at the rear comes into play pressing against their other ends, the grill makes a forward movement and feeds the splints into the holes of a large metal conveyor-platform, which keeps slowly moving. The end of each splint is thus firmly fixed in a hole in this platform, and

as these holes are spaced apart a short distance from one another, the splints cannot touch each other. At first the splints stick out under the conveyor-platform, and in this position are transferred slowly by the moving platform over a heating arrangement to the paraffining apparatus, and then through the chocolate-coloured dipping solution. At the last named, each splint is furnished with its little spherical head, which is made of some igniting mixture, the chief ingredient of which is chlorate of potash. After this, the conveyor-platform passes round a drum, 42" in diameter situated at the rear of the machine. The treated splints are thus brought automatically on the upper side of the platform, which now looks like a gargantuan pin-cushion. In this position they are acted upon very efficaciously by a propeller fan, which, revolving over them at an enormous speed, helps to dry them. Continuing thus, the splints on the conveyor-platform arrive at the upper part of the machine and pass through a channel through which a second fan blows a blast of air, so that a complete drying of their heads is effected. The conveyor-platform then turns downwards once more near the front of the machine, and carries the finished and dried matches in front of the discharging apparatus, which pushes them out into a leather receptacle, from which they are carried to the machine which fills them into the boxes.

8. In the meantime in another apartment, the drawers and the box-covers are being made. For the construction of the former, the bottom and side pieces obtained direct from the slicing machines mentioned above are used, each kind being packed one over another in these drawer-making machines. The bottom pieces are put on a moving horizontal platform and the side ones on a vertical descending one inside a tube. Inside a brass funnel near by the latter is the paste, and on the left of the machine, wrapped up in a roll like a cinema film, is the blue paper cut to the required width. As the machines work, with clock work precision, the drawers are shot out from below beautifully and completely made. The newer kind of machines can make 50 drawers in a minute. In a similar machine the box-covers are made, 50 to the minute. All the above machines are worked by

young Burmese girls, who have become thoroughly *au fait* in their manipulation. To see these drawers and box-covers being ejected so well and completely made, reminds one forcibly of the legendary machine where the pigs go in at one end and ready-made sausages and pig skin boots come out at the other.

9. The constructed drawers and boxes are then put on a large moving platform, which carries them to a chamber where they are dried for half an hour, and then conveyed to the filling machines. In each of these machines the box-covers are put in one tube, the finished splints in another and the drawers on a moving horizontal platform. The machines do the rest, and not only fill the requisite number of splints into each drawer, and push the filled drawer into a cover, but also by means of a pair of revolving circular brushes smear the two sides of the filled box with the dark-coloured substance for striking the matches on, the chief constituent of which is, it is believed, phosphorus. These filled boxes are then dried for a short time in a steam-heated chamber, after which they are carried to the machines which fasten the different kinds of labels on them. After this they are again dried for a short time, and are then taken to the last machines of all, which, not only make the familiar paper packets of ten boxes each, but also stick on labels to each packet. It is believed that the output of each of these packing machines is 50 packets to the minute. The finished packets are then steam-dried as before and then packed for exportation. 120 packets are put into each tin case and six tin cases are put in each wooden box.

10. It will thus be seen that the whole of the manufacture of matches in Messrs. Lim Soo Hean & Co.'s factory is done by machinery. This machinery, it was noticed, was supplied by A. Roller & Co., of Berlin, and to give the devil his due, to the inexperienced eye of the writer, it seemed to be extremely efficient and ingenious. It appears that a German engineer erected and managed at the beginning the machinery, and a German chemist worked out the formulæ for the different igniting and striking compositions for Messrs. Lim Soo Hean & Co. But since the

advent of the war, or possibly even before that time, the whole factory has been efficiently managed by a Burmese gentleman. The entire business speaks very well for the enterprise and business acumen of Messrs. Lim Soo Hean & Co. It is up to the general public, therefore, to give not only this firm, but also the other match-manufacturing firm in Mandalay, every encouragement by using their matches in preference to imported ones. If memory serves the writer right, the Viceroy, Lord Chelmsford, on his departure from Burma, took with him several cases of these locally made matches, and our late Lieutenant-Governor, Sir Harcourt Butler, ordered that these matches only should be used in Government House. It is also up to the Forest Department to give these firms all the help and advice they need. Both Letpan and Shawbyu flourish in places where no very valuable species can be grown. Also, both these species are soft wooded and quick growing. It will, therefore, be a moot question when funds and personnel permit, whether it will not be feasible to have plantations made of these two species and work them on short rotations.

BIG TEAK IN BURMA.

BY C. G. ROGERS, I.F.S.

The Mehaw Reserve in the Pyinmana Division of Upper Burma has always been noted for its big trees. The reserve lies on the outlying foot-hills of the Shan plateau to the east of the Sittang. Owing to the steepness of its slopes and the unsuitability of its streams for floating purposes, very little extraction has been done in the past, and it is only lately as the result of girdling operations that much work has been done there.

The underlying rock is nearly everywhere a granite, which has been for the most part subjected to a severe dynamic metamorphism. The resultant gneisses are of various colours and much of the rock is porphyritic. These rocks are capped in the east of the area (chiefly) with laterites of recent origin. Where laterite is absent the soil is a rich, though shallow, sandy loam.

The rainfall is about 65 inches. There is much bamboo, and the general character of the growth is moist deciduous hill forest with a tendency to evergreen in the valleys and on the hill tops. Seedling and sapling teak are in great deficit and the largest class is over-represented, and the trees are probably too old to bear fertile seed. The regeneration of the area is, therefore, a problem which is still unsolved. Fire-protection has not yet been introduced, and the naturally heavy shade is probably responsible for the poor reproduction.

The available staff and money are all absorbed by equally rich but more accessible forests elsewhere, so there is no present likelihood of any artificial interference being possible.

The working-plan spreads the removal of the surplus over mature trees over two felling rotations of 20 years each, 37 years being estimated as the time required for trees to pass up from a girth of 6' to 7'. Nominally, the girth limit for girdling is 7'; but, in practice, this has been in many compartments 12', to avoid excess girdling. Consequently, the girdling officer notes for compartment 11, for instance, that 40 trees have girths between 14' and 20' and that the average estimated content of these trees was 10 tons each.

Messrs. the Bombay Burma Trading Corporation, Limited, have commenced felling the girdlings of 1910-11 and the late Mr. Cook, of that firm, has kindly given the logging results for five trees which he considers exceptional.

These are as follows :—

RECORD TREES.

Mehaw Reserve.

Pyinmana Division.

Compartment 12—

	Length.	Girth.	C. feet.	Total.	
1	28 ...	13' 6"	318.9	=861.9	17 tons.
	28 ...	12' 5"	269.7		
	24 ...	8' 9"	114.8		
	22 ...	6' 5"	56.6		
	33 ...	6' 7"	89.4		
	18 ...	3' 4"	12.5		
2	23 ...	13' 6"	262.2	=662.7	13½ tons.
	33 ...	12' 5"	317.9		
	22 ...	7' 9"	82.6		



Photo. Mechl.-Dept., Thomason College, Roorkee.

Photo by C. G. Rogers.

Gamon Forest Reserve, Pegu Yomas Zigôn Forest Division. Compartment No. 34.

A flat alluvial soil near bed of stream. Altitude 500 feet above sea-level.

Teak tree, height 153 feet (taken with Abney's level), girth at breast-height 15 feet 10 inches.

Photographed 28th February, 1911.

	Length.	Girth.	C. feet.	Total.	
3	32 ...	13' 6"	364·8	=737·1	14½ tons.
	37 ...	12' 4"	351·0		
	12 ...	5' 4"	21·3		
4	30 ...	11' 3"	237·0	=531·1	10½ tons.
	31 ...	10' 2"	200·3		
	25 ...	7' 9"	93·8		

Compartment 25—

5	14 ...	18' 0"	280·0	=686·8	13½ tons.
	14 ...	12' 0"	126·0		
	27 ...	11' 0"	204·0		
	17 ...	8' 6"	76·8		

These splendid trees grow on the rich soil at the foot of the slopes—soil, which though level, is still well drained. It should be added that these enormous logs are being carted out on the ordinary buffalo-cart used for timber extraction.

The photograph accompanying this article (Plate 29) is that of a large teak tree growing on flat alluvial soil, near the bed of stream, at an altitude of about 500 feet above the sea, in compartment 34 of the Gamon Forest Reserve, on the Western slope of the Pegu Yomas in the Zigôn Forest Division. It shows that equally fine trees grow in other parts of Burma. The height of the tree measured with an Abney's level was 153 feet and the girth at breast-height 15 feet 10 inches.

The stump to the right of the tree is that of a teak tree, nearer the camera, of about the same size.

The photograph is an enlargement from a negative taken by the late Mr. E. V. Ellis, Deputy Conservator of Forests, Burma list.

IMPORTS OF JARRAH TIMBER INTO BRITISH INDIA

DURING THE YEARS 1912-13 TO 1916-17.

Our readers are requested to refer to the article bearing the above heading on page 229 of the *Indian Forester* for May 1918.

On enquiry we find that during the quinquennium in question a large number of Jarrah wood sleepers were imported into British India. These sleepers, it now appears, were not included in the figures for imports of Jarrah wood into India obtained from the Director of Statistics, having been classified as "Materials for Construction-Sleepers" under Railway Plant and Rolling-stock—

vide Annual Statement of the Sea-borne Trade of British India issued under the authority of the Government of India. This explains the apparent discrepancy pointed out by Messrs. Millar's Timber and Trading Company, Limited, Bombay.

NOTE ON THE DYING BACK OF SAL SEEDLINGS.

BY E. A. SMYTHIES, I.F.S.

I have never seen any figures published which showed the proportion of Sal seedlings which die back, the period when they die back, and the effect of light and shade on their dying back. The following notes on a small experiment I carried out this year to try and throw some light on these points may be of interest:—

Type of Forest.—Pure Sal of good quality, very well stocked with poles and mature trees. Fairly dense undergrowth Sal reproduction established in groups here and there, where overwood was not too dense. One-year-old seedlings everywhere, the result of a good seed year in 1917.

Soil.—Elevated river gravels (upper Siwalik conglomerate) giving a porous rather dry soil, but excellent for Sal.

Slope and Aspect.—A plateau sloping very gently south. Two acres were selected side by side—I acre (A) had all growth cut flush with the ground, except about 6 or 8 Sal standards left to give a very light overhead shade—I acre (B) had no felling at all and seedlings were left in the dense shade of overwood plus undergrowth. In the middle of each acre (A) and (B), a patch of 10 yards square (900 sq. ft.) was demarcated and the seedlings counted periodically. The following interesting results were obtained:—

Date of counting.	No. of seedlings.		Weather conditions.
	A	B	
1st January 1918 ...	1,654	1,400	January—Rainless. No frost.
February 1918 ...	257	1,220	February—Ditto.
March 1918 ...	252	1,040	March—Good showers on 20th and 25th. Hot.
May 1918 ...	504	550	April—Several good showers between 1st and 15th.
June 1918 ...	603	369	May—Rain on 18th. Hot.

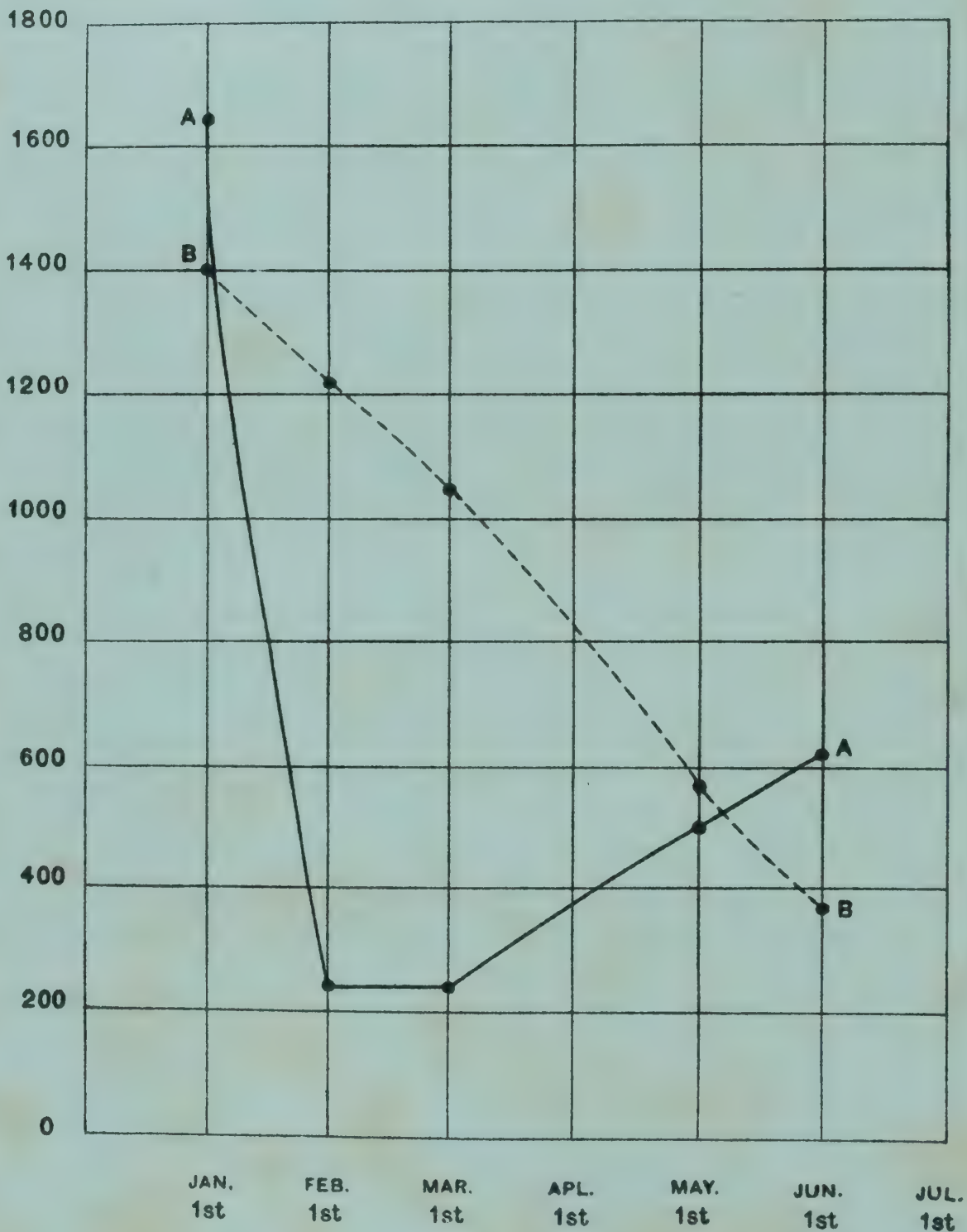
NOTE.—The heavy felling in (A) was done early in January.

COUNTING OF SAL SEEDLINGS

A.—UNDER LIGHT SHADE.

B.—UNDER HEAVY SHADE.

No of seedlings



I have put these figures graphically in the attached curves (Plate 30) and they show most clearly the very marked effect a heavy winter felling has on one-year-old Sal seedlings. These figures and curves indicate—

- (1) that under heavy shade, Sal seedlings continue to die back very regularly all through the cold weather and hot weather. In this case 75 per cent have died back, or rather more than this, as the number 369 includes a certain number of seedlings which have died back and since shot up again ;
- (2) that a heavy clearance and removal of shade causes those seedlings, which are going to die back, to do so *immediately*. In this case, to the extent of 85 per cent.;
- (3) that at the beginning of the hot weather many of the seedlings which have died back in the felled area shoot up again and persist through the hot weather. (It should be noted that weather conditions were very favourable, with excellent rain in April and again in May.)

This effect does not occur in the shaded area to anything like the same extent.

What conclusions can we draw from these three established facts ? Obviously, we can draw no sweeping generalizations from one small experiment carried out in one favourable locality for a favourable half year. But we can, I think, say that these figures do suggest that a heavy and almost complete clearance is not bad even for one-year-old seedlings in favourable localities. This is not the recognized principle for Sal. We know that *established* Sal reproduction, 4' or 5' high, can be clear, felled over to its great advantage (barring, of course, frost localities), but Sal seedlings are usually kept in shade until they have established themselves, a period which may take anything from 5 to 20 years or more. By the beginning of March, I had come to the conclusion that a heavy felling was fatal to Sal seedlings and never imagined that my (A) and (B) curves would cross each other again.

It looks as if the dying back of Sal seedlings is really no setback at all, but rather an advantage, and the following observation supports this contention. Several individual seedlings have been numbered, measured and noted on.

It has been found that those seedlings which have not died back have, on the whole up to 1st June, shown no sign of growth this year. Presumably the root-system could only cope with the transpiration from the two original opposite leaves, and had nothing to spare for fresh growth. Many of the seedlings which had died back, on the other hand, have already thrown up new healthy shoots to equal the last year's growth which they lost. If from this we may argue that the early dying back of seedlings is not a disadvantage, but enables them to start growth earlier, under the stimulus of light, we have again an indication that heavy winter fellings for the development of Sal seedlings may be advantageous. But, as I have already said, no final conclusions can safely be drawn from this one little experiment, but possibly more extensive observations and research on these lines might give us some interesting results.

GOVERNMENT OFFICERS, BURMA.

The following is a list of the Local Government's officers who have been set free, or are in course of being set free, for military service since the man-power resolution of the 14th May was passed :—

FOREST DEPARTMENT.

F. W. Collings, Deputy Conservator of Forests ; A. H. M. Barrington, Deputy Conservator of Forests ; A. P. Davis, Deputy Conservator of Forests ; J. B. Mercer Adam, Deputy Conservator of Forests ; C. K. Hargreaves, Deputy Conservator of Forests ; G. S. Shirley, Deputy Conservator of Forests ; E. W. Carroll, Assistant Conservator of Forests ; A. E. Eden, Assistant Conservator of Forests ; D. A. Allan, Extra-Deputy Conservator of Forests ; F. W. Wright, Extra-Assistant Conservator of Forests ; C. E. Parkinson, Extra-Assistant Conservator of Forests ; F. G. Edwards, Probationary Extra-Assistant Conservator of Forests ; G. P. Walden, Probationary Extra-Assistant Conservator of Forests. —[*Rangoon Gazette.*]

OBITUARY.

LIEUT. GOLDBERG REPORTED KILLED IN ACTION.

In a private message received in Rangoon, Lieut. G. H. A. Goldberg, I.A.R.O., attached to Punjabis, is reported to have been killed in action in Palestine recently. Gordon Henry Archibald Goldberg was born on December 6th, 1887, and arrived in Rangoon on December 28th, 1910, on appointment to the Burma forests. He was first posted to Tharrawaddy and later saw service in the department in the Maymyo, Yaw, Mandalay, Meiktila, Kindat and Insein forest divisions and was on duty in Rangoon at the time he received his commission in the I. A. R. O., which was in February 1915. He was posted to the 91st Punjabis on first appointment.

EXTRACTS.

PRODUCTION OF WOOD TAR IN INDIA.

A large import of tar from Sweden into this country has now been practically cut off, and to replace this trade with a local commodity, numerous experiments have been carried out at the various forest centres where tar-bearing timbers are extant. Wood tars are divided into two heads, *viz.*, wood tar and Stockholm or pine tar. Stockholm or pine tar is essentially a very cheap varnish consisting of resin, turpentine, and tarry oils. It is obtained by burning resinous pine in various forms of kilns with special bottoms to drain off the tar from the wood which is being carbonized. The wood is cut into small pieces and stacked in layers. The fire is inside the kiln and kindled at the bottom.

In spreading upwards the vapours escape at the top and flowing down the sides escape by collecting in the special bottom from which it is tapped. Various types of kilns are still in the experimental state, and a disadvantage of the pines in India is that they are not so highly resinous as the European pine. The result is that the tar distilled is proportionately more expensive than the European product.—[*Indian Engineering*.]

[NOTE.—We are unable to endorse our contemporary's statement that Indian pine wood is not so resinous as the European pine. *Pinus longifolia*, the long-leaved pine of the Himalayas, which is the almost exclusive source of Indian pine resin, is very rich in resin, especially trees which have been tapped for resin. The wood of such trees, especially stump wood, which is very largely used, is frequently saturated with resin, so much so that this wood is heavier than water.—HON. ED.]

Extracts from Agenda of the fifteenth meeting of the Board of Industries held at Cawnpore on the 25th April 1918.

The Board noted with appreciation that Government has been pleased to sanction a grant of Rs. 10,000 for experiments in tannin and other dye extracts, and a loan of Rs. 30,000 to Mr. A. H. Mirza, Proprietor of the Ramnagar Cutch Factory.

The Board was pleased to note that the Government of India have authorized the Local Government for the provision of 1st class tickets to all State scholars during the period of war, for the journey from Marseilles to London as long as the conditions of travelling in France render it necessary. It was also noted that facilities are procurable in the United Kingdom for the study of wood distillation.

THE TREATMENT OF TIMBER.

I.

The silence of the Forest must have fallen on the officers of the Forest Department to have kept them for six years from making public the extensive work that has been quietly carried on since 1912 in connection with the antiseptic treatment of sleepers. But it has been better so, better now to take up their record of a few really fruitful years of work and to learn that what has been so

long only hopeful speculation has been worked up into solid realization, that no doubt whatever now exists as to India possessing a long list of forest trees which can easily be called upon to supply for many years to come all the sleepers she needs for her railways if only the railways themselves will rise to their responsibilities and take out of the hands of the overburdened Forest Department that part of the business which, after all, most concerns themselves. We used to be astonished when we saw in American journals the long lists of timbers on which railways in the United States and Canada relied for their timber supplies and often asked ourselves what was wrong with our 250,000 square miles of Indian forests that they were not producing more than half a dozen kinds of sleepers while the cry constantly rang that these kinds were already being exhausted and we must go outside India for our supplies or turn to metal, and ferro-concrete sleepers. Looking at Mr. Pearson's note in the Indian Forest Records, it is quite a relief to find that after all there was nothing wrong with the forests, that the timbers were there and only wanted some one to come and find out. Mr. Pearson has done this. His farther note on the "Antiseptic Treatment of Timber, recording results obtained from past experiments" is so replete with information that on reviewing it there is a difficulty in finding the point at which one should begin. We have deliberated and concluded that we had better first turn to page 97, Part VI, which deals with factors governing the treatment of sleepers. Obviously, these demand first consideration since even the fool might ask—why treat a sleeper at all before you know it is worth while? Let us then see what some of these factors are.

First then, Mr. Pearson brings up to date the list of Indian timbers that he has ascertained to be suitable for railway sleepers after treatment. To our astonishment this list extends to 32 species. It is divided into three classes, *viz.*, Class I, comprising timbers which are most likely to fulfil the necessary requirement; Class II, comprising the next most likely species to fulfil the necessary requirement; Class III, possible sleeper woods. In Class I there are twelve species, in Class II ten species, in Class

III eleven species; and in each class there might very well be more but for the fact that the absent species are in such demand for other purposes as to make their available quantity and price prohibitive for sleeper purposes. All the sleepers in all three classes answer the demands that govern suitability for sleeper use which are—(1) that the available supply should be large, (2) that the cost of the timber and a suitable treating plant be not excessive, (3) that the timber be of sufficient strength for the purpose, and (4) that it should yield readily to treatment. As regards mechanical strength, some of these timbers will not stand use as sleepers without bearing plates, as, for instance, *Pinus longifolia* (chir), *Pinus excelsa* (kail), *Abies pindrow* (silver fir), *Picea morinda* (spruce), and some others. Silver fir and spruce, it may be remarked, are much the same as Douglas fir in character and the latter is a most popular sleeper timber in America. There are others, however, which are hard timbers requiring no bearing plates, such as *Terminalia tomentosa* (sain), *Terminalia myriocarpa* (hollock), *Terminalia manii* (Andaman timber), and others. The capacity for holding the dog-spikes is also an important consideration; and with regard to this the note says—"The spikes were found to be holding moderately well in the case of the pine sleepers, well in the case of the Dipterocarps, while the *Terminalia tomentosa* sleepers held the spikes so strongly that they could only be removed with difficulty." The power of some of these timbers to resist the withdrawal of spikes has been mechanically tested at Dehra Dun, giving the following results:—Deodar, from 3,000 lbs. to 4,000 lbs.; Sal from 4,000 to 5,000 lbs.; Chir, 3,000 lbs.; *Dipterocarpus alatus* (kanyin), 6,000 lbs. to 8,000 lbs.; *Dipterocarpus tuberculatus* (in), from 7,000 lbs. to 8,000 lbs.; *Dipterocarpus pilosus* (hollong), from 5,000 lbs. to 7,000 lbs.; silver fir, 2,000 lbs.; spruce, 2,500 lbs.

We now come to the important subject of seasoning, and, remembering the laxity with which this factor in timber operations is dealt with, too much attention cannot be drawn to the words of Mr. Pearson—"It is difficult to lay sufficient stress on the importance of seasoning timber before treatment, for unless proper care is taken in this respect any undertaking of this nature will be

doomed to failure." If unseasoned, the moisture left in the timber impregnates the fibres and causes decay, it also promotes the growth of fungus and invites attack by insects. The timber is in a condition liable to develop bad cracks and the juices in it resist the entry of antiseptics; in fact, such timber, if treated, will be found on opening out to contain the oil only in irregular patches and streaks. The timber ought to be what is known as "air dry" before treatment, but as the percentage of moisture constituting this condition varies very largely according to locality, the general rule Mr. Pearson lays down is that in dry, hot localities the moisture content should not exceed 15 per cent. and in wet localities 25 per cent. In the dry parts of India seasoning is effected very rapidly but there is the risk of timber cracking badly in seasoning unless protected from the direct rays of the sun. In wet localities it is difficult to reduce moisture to below 25 per cent. by natural seasoning, except for a short period in the hot weather. Artificial seasoning is effected either by steam or oil. In steam seasoning the timber has to be exposed to live damp steam for some hours in a cylinder in which the temperature is raised to about 250° F. and the pressure to about 20 lbs.; then a vacuum of about 20 inches of mercury is applied for an hour or so which extracts a proportion of the moisture both water and sap. In oil seasoning the sleepers are placed in a cylinder together with hot oil and the temperature raised to, say, 230° F., moisture escapes to the top of the cylinder and distills over, and when this has gone on for some hours, heating is suspended, the cylinder filled to the top with oil and a pressure of about 15 lbs. applied for 15 minutes. In this way the sleepers lose a certain amount of sap and absorb a certain amount of oil. But both these operations effect only partial seasoning, though the second gives somewhat better results than the first. Mr. Pearson is of opinion that it is best in wet localities to effect natural seasoning at first as far as it will go and then finish the process in drying kilns.

Of the two processes employed in treatment—open tank and pressure plant—the latter gives the better results. There are, of course, a great many antiseptics for choice and several have been

tried in the Forest Department experiments. Of four—green oil, Avenarius carbolineum, solignum and a liquid fuel—and a fifth composed of definite proportions of the second and fourth, green oil, which is a commercial coal-tar creosote, seems to give the best results in India. There is, of course, the possibility of mixing coal-tar creosote with a petroleum product for the sake of economy, but no general experiment seems to have been made so far with such a mixture. The functions of mineral oils are to distribute the more toxic oils to act as a water-proofing agent to the timber and to either reduce the cost of treatment or to allow of more oil being injected into the timber. Salt solutions, such as chloride of zinc and copper sulphate, have been experimented with in India only in the laboratory; they are not in favour as they are liable to leak out during heavy monsoon rains in this country. Then there are mixed impregnations first with a salt and then with an oil, or with the two combined. The cost of such treatment is small but has not the same merit as treatment with a creosote alone. It is necessary only in certain cases to treat sleepers to refusal, and as to the number of pounds of oil to be given per cubic foot, that depends on the mechanical life of the particular timber, since it is of no use to preserve the timber against decay beyond the point at which it is no longer mechanically fit for duty. For example, *Pinus longifolia* sleepers need impregnation with no more than 5 lbs. per cubic foot, the *Dipterocarp* sleepers with from 7 to 8 lbs., while *Terminalia tomentosa* sleepers should be treated to refusal. Accordingly, open tanks can generally be used if the amount of absorption does not exceed 4 to 5 lbs. per cubic foot and the number of sleepers to be treated does not exceed 30,000 to 50,000; but for heavier impregnation or where larger numbers of sleepers are involved, pressure plants should be employed. We extract from the note the following useful table showing the estimated cost of treating sleepers based on the Forest Department experiments;—

Species.	Locality from whence procured.	Powellized Sleepers.	Avenarius carbolineum.	Chloride of Zinc and Green Oil.	Solignum and Liquid Fuel Oil.
		Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.
<i>Pinus longifolia</i> ...	Chakrata Divn., U. P.	1 1 0 Per B. G. sleeper.	0 12 4 Per B. G. sleeper.	1 1 4 Per B. G. sleeper.	1 5 0 Per B. G. sleeper.
„ <i>excelsa</i> ...	Do.	Do.	Do.	Do.	...
<i>Dipterocarpus tuberculatus</i> ...	Upper Burma ...	1 3 0 B. G.	0 7 3 M. G.	0 9 0 M. G.	0 14 10 M. G.
„ <i>alatus</i> ...	Do.	Do.	Do.	Do.	Do.
<i>Terminalia tomentosa</i> ...	Bombay and Central Provinces.	1 3 3 B. G.	0 9 5 M. G.	1 0 2 B. G.	1 3 8 B. G.

Where solignum and liquid fuel oil were used mixed together two mixtures were tried, first 40 per cent. solignum and 60 per cent. liquid fuel, and, second 33 per cent. and 67 per cent. respectively. Mr. Pearson is of opinion that a good grade of creosote mixed with a cheap petroleum oil would reduce cost considerably. This procedure has been adopted in treating the U. P. chir sleepers, though, in this instance, the amount of oil to be absorbed per sleeper has been raised to 15 lbs., involving a corresponding rise in the cost of treatment. Mr. Pearson also thinks that any treatment which involves a maximum cost of more than Re. 1-4-0 to Re. 1-6-0 per B. G. sleeper is of doubtful practical use. Cheap creosote of good quality is at the basis of the whole question, and so long as India has to import all it wants so long will the treatment of sleepers be handicapped. As to this we are informed that a Calcutta firm is now actually considering the question of manufacturing coal-tar creosote; as a matter of fact, it has been produced, but the firm is engaged upon improving the quality so as to bring it up to specification. There exist no reasons why success should not be achieved.

THE TREATMENT OF TIMBER.

II.

Laboratory experiments in treatment were commenced in 1909 and continued up to 1914, the majority of the specimens having been laid down between 1909 and 1911. The specimens measured $18'' \times 2'' \times 2''$, there were 12 species of timber, and 23 antiseptic solutions comprising both salts and oils employed, and the period of immersion, when possible, was kept constant. After treatment in the laboratory, the specimens together with untreated specimens were put into the ground together in a place known to be infested with white-ants. In the case of the Powellized specimens, after being from 6 to 7 years in the ground, it was found that 50 per cent. of those treated as against 32 per cent. of the untreated specimens remained serviceable; in other words, the average life of the treated specimens proved to be 5 years 2 months and that of the untreated specimens 3 years 7 months. The absolute results do not show up well, but the fact has to be taken into account that timbers of varying kinds were taken from the hardest to the softest and these are the average results. The second group of laboratory experiments was made with Avenarius carbolineum, coal-tar, jodelite, solignum, tar from *Pinus excelsa* and green oil. Ordinary coal-tar and tar from *Pinus excelsa* gave practically the same results, showing an average durability of 3 years 9 months and 3 years 11 months, respectively. The other four antiseptics all gave better results—Avenarius carbolineum 5 years 2 months, jodelite 5 years 4 months, solignum 5 years 7 months, green oil 5 years 8 months. All four are coal-tar creosote preparations and green oil stands first. The average life of the untreated specimens varied from 2 years 8 months to 3 years and 3 months. The third group of laboratory experiments was with créosyl, anthrol, Burma oil and liquid fuel from Borneo; the two first being coal-tar products, the two second petroleum products. The average durability in years of the specimens in the order named was, respectively, 5 years 2 months, 5 years, 3 years 4 months, 3 years 4 months. The average durability,

in years, of the untreated specimens was 2 years, 2 years, 2 years, 1 year respectively. The fourth group of laboratory experiments was with certain salts—atlas solution, Béllit, sodium fluoride and chloride of zinc, and Hylinite. The general results are inferior to those obtained with oils, primarily due to leaching out of the salts. The average durability in years of the specimens in the order named was, respectively, 4 years 6 months, 3 years 4 months, 4 years 5 months, 3 years 9 months. The average durability in years of the untreated specimens was 2 years 10 months, 2 years 6 months, 2 years 7 months, 2 years 11 months, respectively. The fifth group of laboratory experiments was with anticide, MacDougall's insecticide, mort-ant, and Burnettizine. As these experiments, however, cover a period of only from 2 to 4½ years the result cannot be said to be final. The results are quite satisfactory in the case of anticide—4 years 1 month as against 1 year 3 months for untreated specimens; 9 out of 11 specimens treated with MacDougall's insecticide remain after 3 years and 8 months as against 2 untreated specimens. Taking into consideration that of the 9 treated specimens remaining, 5 are for all intents and purposes sound, the results are fairly satisfactory. Mort-ant has given less favourable results than either of the two previous solutions; 5 remain sound out of 11 treated specimens after 3 years and 9 months, while the durability of the treated and untreated specimens is practically the same. The Burnettizine experiment has only been in progress two years, so no definite conclusion can be drawn; the fact that out of 12 treated specimens, 4 have had to be removed, and that 4 others are already seriously damaged, does not hold out any great hopes that their solution will prove to be suitable when employed under Indian conditions. The sixth group of experiments was with crésol-calcium, aczol and barol; all of them antiseptics composed of salts and oils, mixed to form emulsions. Results from crésol-calcium and aczol were extremely poor, but those from barol were promising. Reviewing results of all six groups of laboratory experiments it may be stated generally that the hard and moderately hard woods treated, as compared with untreated specimens, have fared in proportion better than

the soft woods. The results obtained with Powellized timber are fairly satisfactory, but the outstanding feature of the experiments is the superior results obtained with the various coal-tar-creosote products as compared with salt solutions. It is only just possible that salt solutions might answer in very dry localities like Sind and parts of the Punjab, but this remains to be proved.

Having dealt with Mr. Pearson's laboratory experiments we now proceed to his field experiments. The primary object of the first was to test the value of certain selected antiseptics, that of the second to test durability of treated sleepers under practical conditions. First we have the Powellizing process. This consists in immersing the timber in a saccharine solution containing small quantities of arsenic gradually heated up to a fairly high temperature, the time of immersion depending on the density and size of the timber. After immersion the timber is thoroughly dried in a drying chamber. Next there is treatment with Avenarius carbolineum, a coal-tar creosote of good properties but priced in India at Rs. 2 a gallon, which made the cost prohibitive unless impregnation was limited to the use of from 5 to 7 lbs. only per broad gauge sleeper. Thirdly, we have chloride of zinc and green oil, a combination adopted for the sake of economy. It has been pointed out that salt antiseptics leach out in India and are therefore unsafe to use. In this combination the sleeper is first made to absorb as much of the salt as it can, then dried and plunged into a hot bath of the oil of which it is allowed to absorb only a small quantity. This has the effect of forming a thin shell of oil-impregnated tissue on the outside which prevents the salt from leaching out and at the same time prevents its contact with the rail foot which otherwise it would attack. The green oil costs only 13 annas a gallon in India and the whole cost of treating a B. G. sleeper is only $2\frac{1}{2}$ annas. Fourthly, we have a mixture of solignum and Rangoon oil, a combination adopted for the sake of economy, as solignum is expensive. With the Powellizing process the complete cost of a B. G. sleeper handed over to the Railway comes to from Rs. 4-8-0 to Rs. 5-8-0 dependent on the species of timber. With Avenarius carbolineum the cost for a B. G. sleeper is from

Rs. 5-4-6 to Rs. 6-4-6, and the cost for a M. G. sleeper from Re. 1-9-2 to Rs. 2-5-5; but these latter figures are of little value because they exclude royalty and are based upon the use of only 1·1 lb. of oil per sleeper, which is wholly inadequate. As a matter of fact, the cost of adequate protection with Avenarius carbolineum alone is prohibitive and the oil would have to be mixed with some cheap solution, such as Burma oil. The cost of treatment with chloride of zinc and green oil is given as Rs. 4-9-4 per B. G. sleeper; with chloride of zinc and Avenarius carbolineum Rs. 3-0-7. The cost of *Pinus longifolia* sleepers treated with 40 per cent. solignum and 50 per cent. Burma oil is given as Rs. 4-14-0 per B. G. sleeper. The cost of *Dipterocarpus tuberculatus* sleepers treated with 33 and 66 per cent., respectively, of the same oils is given as Rs. 2-10-0 per metre-gauge sleeper.

Presuming that a rapid expansion of railways will take place in India as soon as money becomes plentiful again, this question of treating sleepers in the country on a large scale claims immediate attention. To treat and use the second quality timbers of the country means the development of both forests and railways, a very large sum of money will be kept in the country which unnecessarily goes out of it, and that portion of it that will go into the treasure chest of the Forest Department will go some way towards relieving it of its chronic impecuniosity. We have been fortunate so far in possessing certain sleeper timbers which it would be false economy to subject to treatment; but these have at last begun to fall short of the demand, and because we have not embarked on the policy of other countries and used preservatives to make other species durable enough for railway uses we have had to resort to metal sleepers or imported timber sleepers. The latter have not proved a success in India, obviously because they have been preserved for use in a wholly different climate. The former are only a fair substitute, but with a few exceptions engineers would prefer to have timber for the road. It is unreasonable therefore to allow a large variety of sleeper timber to rot in the forests when they are badly wanted and when it is now proved that they can be safely and economically used. The

exploitation of such timbers as Mr. Pearson has brought to notice will certainly bring down the price of sleepers and as certainly will it be found in time that there are still other timbers in our forests whose merits for sleeper duty only wait to be discovered. We cannot conclude without adding that we trust this further note on the antiseptic treatment of timber recording results obtained from past experiments will find its way into the hands of all railway engineers in India.—[*Indian Engineering.*]

A LUMBER CAMP IN THE HIGHLANDS.

NEWFOUNDLAND FORESTERS AT WORK.

CRAIG OF THE GOATS, PERTHSHIRE.

A century ago, John, fourth Duke of Atholl, resolved to plant the waste mountain sides of his estates with spruce and larch by the million. By the end of the century, said he, his descendants would reap a hundredfold what he had sown. The Napoleonic wars had taught Britain what scarcity of timber meant.

“My plantations,” he declared, “will make up and probably be productive of an income to a much greater amount than that of any subject in the Kingdom.” He said confidently that if one-fourth part of his larches arrived at maturity by the end of the century, they would supply “all the demands of Great Britain for war or commerce.” He planted 15,573 acres, mainly of barren mountain side, with 27,431,600 young trees. Many other northern landowners followed his lead.

For long Duke John's expectations seemed likely to be falsified. Great storms blew down hundreds of thousands of trees. The price of timber fell. The wooden ship on which he had based his plans made way for the iron ship. As cheap rail and ocean transport developed, our timber merchants revelled in the loot of the vast virgin forests of Canada, the United States, and Scandinavia: British forests, like British farms, could no longer compete in their own home markets against this flood of foreign imports. Yet to-day his foresight is proving true. The great

forests of Scotland, utilized mainly during the last two generations as shooting preserves, have suddenly become an enormously valuable Imperial asset. Timber must be had in vast quantities for a hundred war purposes. We cannot import it. We must—now perforce—rely on the resources of our own island. Scotland is supplying more than its share. Men from the ends of the Empire are in the North to-day, clearing the hills, felling and despatching their giant trees with the expedition of a Western lumber camp. Most of them are not Westerners, however, but Easterners, men from Ontario, Quebec, New Brunswick, and Nova Scotia, together with hundreds of picked Newfoundland lumbermen, wearing khaki and serving under military discipline. To the North there has come a sturdy batch of New Englanders.

THE LUMBER CHUTE.

This is a Newfoundland camp on the Atholl estate. A few days ago the Duchess of Atholl, after entertaining a party of woodmen guests, confessed that while she was glad to see them, and hoped to see more of them, her heart was heavy at the disappearance of her beloved woods. One can understand her grief. Here, up on the Craigvinean, the Craig of Goats, as it is rightly called, 800 ft. above the sea-level, one gazes around upon what was one of the most beautiful wooded scenes in Scotland. In the immediate neighbourhood are grouped a succession of fallen giants—great, noble timber. Some distance below a lumber camp can be seen. Along the steep middle ridge of the hillside runs a temporary mountain railway, built with lightning speed to transport the logs to the point where the great chute, 1,400 ft. long, falls vertically, down which the thousands of great felled trunks—often more than half a ton in weight—slide thundering to the mill below. This mill has been completed in incredibly short time, and the whole place has an air of hustling resolution. The rough wooden huts of the men, and the simple, effective machinery, do not seem to belong to an old civilization like ours. Planted down here, one might imagine that you were in Newfoundland. In truth, Newfoundland has transferred its ways to the heart of Perthshire.

"These men work as though they are fighting against time," said an old Scottish factor somewhat resentfully, when he saw the Newfoundlanders set to. "We are," came the ready reply. "That is what we are here for, in war time." At first the Scotch woodsmen were inclined to feel sore at the unconventional methods of these newcomers, and various big challenges were exchanged. The cutting down of trees is a solemn affair. It ought to be done with a certain stateliness. It ought above all to be done sparingly, and with a certain nicety according to estate traditions. That is the old British idea. But here are men doing it wholesale, leaving nothing behind.

It was necessary to find a means of carrying the great trees down from two high levels, 1,800 ft. in all. Experienced local men advised a mountain railway equipped with winding drum and steel cables, etc., which would have taken considerable time to construct, and would have cost something probably running into four figures. The Newfoundlanders laid a simple chute, consisting of a triple line of trunks of trees forming a kind of running trough. The total cost of this, apart from the timber, which they cut on the spot, was a few score of pounds. Down this simple line, built in a few days by the men themselves, with a sloping curve at the bottom to bring the monster logs easily to their place, the great trees now descend. They come to rest in the "Log Pond," which has been built by damming the little stream which adjoins the saw-mill in the meadow at the foot of the hill, and from thence are hoisted by the jack ladders into the mill.

HOW THE NEWFOUNDLANDERS CAME.

How have the Newfoundlanders come to Perthshire? Lumbering on a large scale is comparatively a new thing in Newfoundland itself. The timber growths of the Tenth Island lay mostly unappreciated until, less than half a generation ago, the Anglo-Newfoundland Development Company started its work at Grand Falls. In the spring of this year, when signs of a timber famine threatened, Mr. Mayson Beeton, of the Anglo-Newfoundland Company, suggested to Sir Edward Morris, the Prime Minister of

Newfoundland, that a battalion of Newfoundland lumbermen might be organized for timber-cutting here. The suggestion came at the right moment, for on the previous day Mr. Long had written to Sir Edward Morris, asking for help of this kind. Mr. Beeton, with the Premier and the Director of Timber Supplies, at once went to Lord Derby. Within 24 hours the scheme for the Newfoundland Forestry Corps was arranged. Cables were set to work and recruiting had begun, the organization and direction of the Newfoundlanders being left in Mr. Beeton's hands.

The men now at work so far number about 300, to be increased very shortly, it is hoped, with fresh drafts coming along to about 1,000. The *personnel* of the corps is remarkable. The officers, including Major Sullivan, the O.C., are all of them practical lumbermen save perhaps the Adjutant whose business it is to maintain military administration and discipline. No man is accepted for the Forestry Corps unless he is unfit for fighting, or is well over his early manhood, married and with a family. One veteran of over 60, a general utility man, boasts of 40 years' experience in mills. Another has been nearly 50 years lumbering. There are boys in their mid-teens here, too young to go to France to fight, but determined to do something to help to win the war. On Sunday afternoons one sees the forestry men making friends with the country folk in every village around, looking in every way smart, good soldiers. And when their battalion marches into Dunkeld it is difficult to believe that these same well-set ranks are made up of backwoodsmen who have volunteered their service from the freest life in the world—the life of the woods.

They have received a warm Scots welcome from all—from duke to cottager. The country around the Craig of the Goats is as wildly beautiful as any Scotland has to show. The trees are magnificent. The lumber has been well cared for. The trees run straight and true and high. The axemen talk of some of the timber lovingly, as a connoisseur would talk of fine wine. There was one spruce tree whose main trunk was over 100 ft. long. It was 29 in. in diameter at the stump, and 15 in. in diameter 53 ft. high. They got 97 ft. of timber out of it. The woodsmen count

the rings on the trees to tell their years 90, 95, 100, 105 years old. Duke John planted well!

Even while the Newfoundlanders are cutting down great stretches of the most beautiful countryside large numbers of young Scots women are at work planting new districts afresh, for Scottish landowners realize that under the conditions likely to prevail in the world for some generations ahead their forests will be sources of essential national wealth.—[From a Correspondent in *The Times*.]

DOMESTIC OCCURRENCES

BIRTH.

CANNING.—At Hawkesdale, Naini Tal, on the 4th September 1918, the wife of F. Canning, I.F.S., of a daughter.

INDIAN FORESTER

NOVEMBER, 1918.

FOREST CONSERVANCY.

BY E. A. SMYTHIES, J.F.S.

It seems to me an extraordinary fact that the main results of the work of our Department in India receives, practically speaking, no publicity or recognition. Our annual reports and quinquennial reviews show in numerous statistical tables the results of various aspects of our work, the increases of revenue and output of forest produce, the results of fire-protection, of experiments, the grazing problem, the financial results, etc. Leader writers in the daily papers, reviewers, publicists and the intelligent public generally catch on to the salient points of these reports and comment at length on the constantly improving financial results, for example, or the necessity for new methods of exploitation or of a new commercial branch of the Department. But all these matters in our present stage of development are mere incidentals. The popular and erroneous idea of the activities of the Forest Department is, I think, very typically represented by that inane question

so many of us have so often been asked : "What does a Forest Officer have to do? Do you go round *and cut down trees?*" The stock reply to this, *i.e.*, that our work is exactly the opposite and we have to go round and grow trees, never fails to produce a surprised comment, and yet it is so obviously our main work at present.

In nearly all cases in the beginning, forest areas were not made over to the Department until those areas had been ruined to a greater or less extent and the growing stock reduced to a mere fraction of what those areas were capable of producing. And ever since, silently, methodically, and almost unnoticed, nature and the Department have been at work to build up again the depleted capital.

This duty of the Department is well recognized. Refer, for instance, to the views of the Government of India in their quinquennial review of Forest Administration, 1909-10 to 1913-14.

"In forest administration the object in view is two-fold—first, to conserve and improve the forests and *this is the first concern of the trained staff*"—(our italics). The duty then is recognized, but it seems to me we make very little attempt to show how we are fulfilling our duty. There is a close analogy between forestry and agriculture, if we remember that the agricultural rotation is a year and the forest rotation is 100 years.

In agriculture, we have the seed time in spring, weeding and tending of the crop in the summer, and the harvest in autumn. Our spring started 50 years ago with the commencement of the Forest Department, we are now in the summer of weeding and tending, while the autumn of our harvest is still half a century ahead. This generalization applies only to the *best* of our forests, where organization was started 50 years ago, to the teak forests of Bombay and Burma, the Sal forests of the U. P. and Bengal, the forests of the Himalayas. Many of our forests are still only at the beginning of things. For example, 30 per cent. of the forest areas in the U. P. only came under the Department a short five years ago. But the point I wish to make is that in our highest revenue-producing forests and under the most favourable conditions,

we are still only growing our crop and everything else is incidental. For our incidental exertions we get full credit, for our main and principal work there is no recognition. Let me give an instance. The revenue of the U. P. forests has doubled in the last six years and trebled in the last 20. We underline this in our reports, and higher authorities note and make flattering comments. But who realizes or gives us credit for the fact that since we took charge we have quadrupled our growing stock and before our final harvest ripens we shall quadruple it again?

Let me quote a concrete example which I happen to know of. In the revision of the Naini Tal Working Plan recently careful re-enumerations over a certain area—an area close to Naini Tal itself and subject to heaviest demand—showed that in 35 years, in the face of this heavy demand, we had exactly quadrupled the growing stock (*i.e.*, from 11,000 to 44,000 trees). This is a small but established example of what we know to be happening everywhere.

This has been, is, and for another 50 years will be, the real criterion of our work and the main object of our existence.

This essential fact is more or less recognized by the Department; there is no doubt it is not, and never will be, recognized generally unless we invite attention to it in some way, and make it more obvious in our annual reports and reviews. It is, I admit, not an easy matter to bring this aspect of our work into adequate prominence. It is only on occasions (*e.g.*, the revision of a working-plan and re-enumerations of definite areas at long intervals) that we obtain any statistical data to support our case. But I would suggest that when such examples do crop up, we should give them full publicity. They form a tangible point that can be taken up and noted on in reviews, etc., and then be brought before the public eye. Again, an occasional vivid paragraph in our annual reports would assist to give publicity to this aspect of our work. A reference to Chapter IV of the Forest Code, however, (which prescribes the form and headings of our annual report), will show that there is no suitable heading at all for such a paragraph or subject. It does not fit very well into sub-sections (3) and (4) of

Chapter II (*i.e.*, "Protection of Forests" and "Sylviculture"). The new Chapter IV introduced last year "Research and Experiments" might easily have been made to include researches to show the improvement in our forests, but for the very limited application the present wording or definition of this chapter allows (see addenda slip No. 17). I have never understood why this chapter should have been limited to the record of research and experiment on "the introduction of *new* species and the *utilization* of indigenous growth. Most of our research and experiments, after all, concern themselves with the sylviculture of indigenous species (Chapter II, section 4 (*d*), which allowed for this, has now been deleted, and yet the new Chapter IV does not include it. The latter might with advantage be amended by the addition of the words "and Sylviculture" after "Utilization").

However this is rather a digression. To conclude, the main point I have tried to bring out is that the great work which we are doing is the enormous and continual increase in our growing stock—our Forest Capital—for the benefit of posterity, and that this aspect of our work receives a very inadequate recognition.

NOTES FROM DEHRA DUN HERBARIUM.

No. III.

Continued from "Indian Forester," XLIV, p. 349.

SOME INDIAN SPECIES OF ZIZYPHUS.

BY R. S. HOLE, FOREST BOTANIST.

In 1862 Edgeworth described a Punjab plant which he assigned to *Zizyphus Jujuba*, Lamk., and called variety *hysudrica* (*Journ. Linn. Soc.*, VI, 201-202).

The following notes regarding this plant are taken from Edgeworth's description :—

"I am not sure that it is anywhere truly wild, though I have observed it in the desert, but probably dropped by man or bird. This species is immediately noticed on entering the western part

of the Cis-Sutlej States, where it first appears as a small tree (the branches not drooping as the typical wild or cultivated *Jujuba*) and with almost smooth leaves. There is a slight pubescence in young specimens, but they are almost glabrous when old. The fruit is globular and dark coloured (greenish purple), not orange or red like the wild Ber, or green (or yellow) like the cultivated. The leaves are usually roundish ovate."

In India, *Zizyphus Jujuba*, Lamk., is remarkably constant as regards the presence of a dense pale or ferruginous tomentum on the under-surface of the leaves and the length of the petiole, but in both these important characteristics Edgeworth's plant differs strongly from *Jujuba*, apart from the shape of the leaves, habit and colour of the fruit. Judging from the observations and herbarium material at present available, the writer is inclined to consider that this plant is a good species quite distinct from *Zizyphus Jujuba*, Lamk., and probably more closely related to *Z. Spina-Christi*, Willd.

The chief characteristics which at present appear to distinguish *Z. hysudrica* from its nearest allies and also the sheets in the Dehra Dun herbarium which the writer is inclined to assign provisionally to this species are enumerated below:—

1. *Zizyphus hysudrica*, sp. nov. (= *Zizypus Jujuba*, Lamk., var. *hysudrica*, Edgeworth in *Journ. Linn. Soc.*, VI, 201-202, 1862). Leaves oval, broad-ovate to orbicular, glabrous or glabrescent below, nerves prominent above, petioles attaining 0·7 inch, frequently $\frac{1}{4}$ to $\frac{1}{3}$ length of leaf. Usually armed.

Aitchison 140, 182, Rawalpindi; Duthie 6,623, 6,624, Ajmer, 7,129 D. Ismail Khan; Gamble 23,383, Lahore; all in herb. Dehra Dun.

2. *Zizyphus Jujuba*, Lamk.

Leaves ovate or oval to elliptic, densely pale or ferruginous tomentose below, nerves depressed above, petioles very rarely exceeding 0·4 inch or $\frac{1}{8}$ length of leaf. Usually strongly armed.

3. *Zizyphus Spina-Christi*, Willd.

Leaves elliptic to elliptic-lanceolate, glabrous or glabrescent below, nerves prominent above, petioles attaining 1.0 inch, frequently $\frac{1}{4}$ - $\frac{1}{3}$ length of leaf. Usually unarmed.

Zizyphus Spina-Christi, Willd., is believed to be sparingly cultivated in the Punjab and probably elsewhere in the neighbouring provinces. It is a widely distributed species, extending from Africa through Egypt, Arabia, Palestine, Persia, Afghanistan and Baluchistan to N.-W. India. The writer is inclined to assign provisionally the following sheets in the Dehra Dun herbarium to this species:—Lace 3,422, Sibi and a sheet without number collected at Ahmedabad and received from the Poona College of Science in 1893. Lace, speaking of the vegetation near Sibi (*Journ. Linn. Soc.*, 28, p. 294, 1890), says that this seems to have been "the only tree cultivated by the people near their villages until recently." This species in India is sometimes called *Z. Spina-Christi*, Lam. This is probably due to a confusion with an entirely different plant with a dry winged fruit, viz., *Paliurus aculeatus*, Lam. = *P. Spina-Christi*, Mill.

Hasselquist thinks that *Zizyphus Spina-Christi* is the tree from which the crown of thorns was taken which was put on the head of our Saviour during the crucifixion, but the more general opinion is in favour of *Paliurus aculeatus*.

There is still another plant with glabrous leaves with which *Zizyphus hysudrica* has been sometimes confused, viz., *Zizyphus Lotus*, Lam. This is a native of N. Africa and the Mediterranean region and it does not yet appear to have been definitely recorded from N.-W. India. The writer has seen no authentic specimens of this plant, but it is usually described as being a shrub (not a tree) with ovate-oblong leaves, not exceeding 0.5 in. long and with very short petioles which does not square with *hysudrica*. Moreover Edgeworth, after visiting Kew, distinctly says regarding *Z. hysudrica* "at first I had referred this to *Lotus*, but on comparison I find it is quite distinct." (*Journ. Linn. Soc.* VI,

201). *Zizyphus Lotus* is supposed to be the Lotus of the ancient Lotophagi :—

“ The trees around them all their food produce,
Lotos the name divine, nectareous juice,
Thence called Lotophagi, which whoso tastes,
Insatiate riots in their sweet repasts,
Nor other home nor other care intends,
But quits his house, his country, and his friends.”

Finally, it is interesting to note that Dr. J. L. Stewart combined *Z. hysudrica*, *Z. Lotus* and *Z. Spina-Christi* in a single species under the name *Z. Lotus*, Lam., while he kept *Z. Jujuba*, Lam., distinct as a separate species, thus emphasizing the differences between *hysudrica* and *Jujuba* which were somewhat obscured by Edgeworth's treatment.

From his actual description, however, it appears that the *Z. Lotus* of Stewart is mainly the plant defined in this paper as *Z. hysudrica*. Thus he describes the leaves of *Z. Lotus* as “ broad-ovate (or oval), to orbicular * * * under side often covered with white or yellowish tomentum or subglabrate * * * petioles 0.2—0.5 in. * * * fruit 0.5—0.6 in. long, smooth and black young, with age rugose, greenish purple or dark reddish brown,” as against the following given for *Z. Jujuba* :—

Leaves “ from oblong-ovate to nearly orbicular * * * very closely tomentose under * * * petioles 0.2—0.4 in. long * * * fruit 0.7—1.0 in. long, dark brown or reddish yellow.”

Of his *Z. Lotus* Stewart also writes as follows :—

“ The plant here described is not uncommonly cultivated as single trees and in groves—perhaps the most common of the cultivated *ber* in some parts—all over the Punjab plains from Peshawar to Multan, and eastward to near the Jumna, in some places appearing to be wild or quasi-wild. It is common ‘ about villages ’ in north-eastern Afghanistan and reaches 3,500 ft. on the eastern skirts of the Suliman Range, Trans-Indus. * * * It grows to be a largish tree with a trunk of 9—10 or at times 11 ft. girth and a broad, rounded crown to 40 ft. high, in habit and

general appearance much resembling *Z. Jujuba*, but its terminal branchlets do not appear in any case to droop. Its twigs are smooth and whitish with a reddish or bluish tinge, the bark of the trunk is lightish or dark grey,—in very old cases at times brown, furrowed with longitudinal wrinkles. The spines have often lapsed from the older branches. It flowers chiefly during the hot weather, the fruit ripening from September onward during the cold season.

* * It probably yields much of the excellent fruit grown in special places, *e.g.*, about Pākpatan near the right bank of the Sutlej, to collect or eat which people will come a hundred miles."

Further specimens and observations likely to increase our knowledge of *Zizyphus hysudrica*, *Z. Spina-Christi*, *Z. Jujuba* and *Z. Lotus* and of the extent of variation in these species will be welcome at Dehra Dun.

The existing records of *Zizyphus Spina-Christi*, Willd., from the Indian region are as follows :—

Edgeworth (*Journ. Linn. Soc.*, VI, 200) who says it is sparingly cultivated in the Punjab.

Lace and Hemsley (*Journ. Linn. Soc.*, XXVIII, 314) who report it from British Baluchistan.

Boissier (*Fl. Or.* II, 13) who refers a specimen of Griffith's from Afghanistan to this species.

As Edgeworth and others point out, however, there are differences between the Indian tree and *Zizyphus Spina-Christi*, Willd., of Africa and Syria and it is possible that more complete material will show that the Indian tree, which is now provisionally assigned to this species, is really distinct. It is also possible that the tree now known as *Zizyphus Jujuba*, Lamk., in India will be found to be a distinct species from the common small shrub of that name (var. *fruticosa*, Haines), as has been suggested by Haines (*For. Fl.*, Chota Nagpur, 1910, p. 270), and Parker (*Forest Flora of the Punjab*, 1918, p. 84).



Photo -Mechl. Dept., Thomason College, Roorkee.

Photo by R. R. Chandikar, Forest Surveyor.

FLOWERING CORYPHA

NOTE ON CORYPHA PALM IN NORTH KANARA.

The following notes taken from Mr. P. E. Aitchison's Working Plan for the Corypha Palm found in the Honnawar Forests in North Kanara, District Bombay, may be of interest :—

Though the palm is found in small quantities in several localities in the district, its chief home is an area of 25,000 acres in the hills on the Western Ghats near Honnawar. The palm is gregarious and grows in patches varying from a few acres to large belts extending along a hillside. In some places the forest is pure, in other places the palm is mixed with deciduous species adjacent to evergreens.

When the palm flowers it dies. The age at which it flowers was found difficult to determine. It is a prolific seed-bearer and a single palm is said to yield over 560 lbs. of seed. The seed is about the size of a marble quite round, horny, hard and smooth. It requires about six weeks to two months to germinate, very few seeds fail and seedlings appear in great abundance. One palm produces enough seed to stock several acres of ground. The seeds are washed down the hills and are also distributed over the forest by birds, squirrels and porcupine. Deserted fields may suddenly become covered with the seedlings. A few palms or clumps of palms may be found in flower every year, but a general seeding occurs at long periods.

By comparing the age of deciduous trees found on old Kumried areas, that is on areas cut over and burnt for shifting cultivation, the age at which the palm dies is found to be about 90 years. Though 90 years may be taken as the age of the tree when grown in favourable localities, the age at which it seeds would vary under different conditions and might be much less than 90 years in unfavourable localities.

The growth is at first very slow. The palm is valued by the Marathas and poorer classes for its pith which provides a useful food in the form of flour. This pith is found in mature trees only. The mature palms usually swell towards the centre portion of the stem and the local Marathas are able to discern which palms will

yield this flour and are fit to fell. A mature palm should yield at least 8 headloads of pith—many would yield twice this quantity if left to develop fully. The pith is generally dried in the sun or at times on a wooden platform over a fire. One head-load of pith yields about 30 lbs. of dried flour and the market value is 4 annas per maund of 28 lbs.

The young unopened leaves are used for umbrellas, the leaf being cut in half and dried. Full grown open leaves are used for thatching. The leaves are sold at Re. 1 per 100 as half leaves for umbrellas, or as whole leaves for thatching at the same price.

The leaves are cut from small palms and seedlings. Their removal seems to interfere little with the growth of the palm. The seeds are used as beads, buttons, etc.

NOTE ON THE PROSPECTS OF MANUFACTURING PAPER-PULP FROM HIMALAYAN SOFT-WOODS AT THE PRESENT DATE (JULY 1918).

BY WILLIAM RAITT, F.C.S., CELLULOSE EXPERT, ATTACHED TO THE FOREST RESEARCH INSTITUTE, DEHRA DUN.

1. The woods referred to are Spruce and Silver Fir—white wood only.

2. The manufacture is that of ground or mechanical wood-pulp by the aid of water-power, either direct or transmitted electrically. Chemical processes are unsuitable in this country and need not be considered.

3. The essential conditions are a manufacturing site where raw material, power and a rail outlet for products can meet. Rail outlet, if not actually on the spot, should be within a few miles. Power required is about 70 H. P. per ton of dry pulp per 24 hours, 5 tons per day requiring, say, 350 H. P.

4. A considerable change has come over the prospects of this industry during the last four years. As a general rule if a raw material is of any value for any other purpose, constructional or manufactured, it is of too high a value for the paper-maker,

and these woods can no longer be regarded as little better than waste products. Other uses have been found for them which give them a value higher than their pulping value. Only the waste from these uses can now be regarded as having a pulping value. A similar revolution in values is happening with the corresponding species in Europe and America. Obviously, the result of this is to reduce the world's output of wood-pulp. Obviously again, this introduces a counter-balance in the shape of increased value of the product. The cost of imported mechanical wood-pulp, ex-ship Calcutta, early in 1914 was about Rs. 75 per ton. After war, when normal trading conditions are restored, it will not be less than Rs. 90 per ton—not enough to balance the revolution in values alluded to above, but enough to render possible propositions for pulping waste which previously were impracticable.

5. The waste referred to is the smaller ends, and logs too small to be worth saw-milling, say, from 8" diameter down to 4". If these are brought out of the forest, a considerable addition will be made per tree to the percentage of utilization. Also saw-mill waste in the shape of short ends, balks and blocks made in cutting sleepers, etc., to size and any other waste of this nature of 4" cube and upwards can be so utilized.

6. When attached to a saw-mill, a pulping installation may be of comparatively small size, down to, say, an output of 6 tons dry wood-pulp per week. This would utilize about 8 tons per week of small logs and saw-mill waste.

7. The cost of such an installation depends largely on whether hydraulic power has to be developed for the saw-mill in any case. In such an event the additional power required for a pulping plant would cost comparatively little. If the saw-mill has a steam plant as well, which can supply steam for drying the pulp, another economy in first cost would be obtained. A rough rule is that where water-power and steam have to be provided *exclusively for pulp*, the capital cost is somewhere about Rs. 150 per ton of output per annum, but this is for large installations having pulp exclusively in view. The plants I am at present thinking of

are small ones as adjuncts to saw-mills. In such cases, assuming that hydraulic works providing a sufficiency of water for pulp have already been provided for the saw-mill and that only the additional turbines will be required and that a small steam drying plant must be supplied specially for pulp, then a rough approximate figure for the cost of a 6-ton per week pulping plant will be Rs. 30,000.

8. The profit to be earned will depend largely on the locality and its position in respect of railway charges on product to market. I therefore deal only with the approximate gross profit earned at the mill. I assume a value of 3 annas per c. ft. for the timber so used. Probably the mill waste should be taken at firewood value only. I also assume a selling value for pulp of Rs. 90 per ton at Calcutta and that there are no charges for supervision, this being provided by the saw-mill staff:—

	Rs.	a.	p.
∴ 110 c. ft. timber at 3 as. per ft.	20	10	0
Labour for manufacture per ton pulp	6	0	0
Depreciation and repairs on plant. 10 per cent on Rs. 30,000. Output 300 tons per annum per ton	10	0	0
Cost per ton	36	10	0

leaving Rs. 53-10-0 per ton of gross profit available for railway freight and nett profit. A rough average for railway freight to Calcutta is Rs. 20 per ton in Punjab and Rs. 25 in the U. P., and possibly this may be reduced by shipping from Karachi. There is, therefore, a prospect of a nett annual profit from such small installations attached to saw-mills of, say, Rs. 9,000.

The above assumes mill waste and saw-dust is available at no cost as fuel for drying pulp.

ZALOKKYI FOREST REST-HOUSE, MAIN BUILDING.



Fig. 1. Third day—shews the posts being erected by means of block and tackle.



Photo.-Mechl. Dept., Thomason College, Roorkee.

Fig. 2. Sixth day—shews the girders being put on and the scaffolding for the post plates in the course of construction.

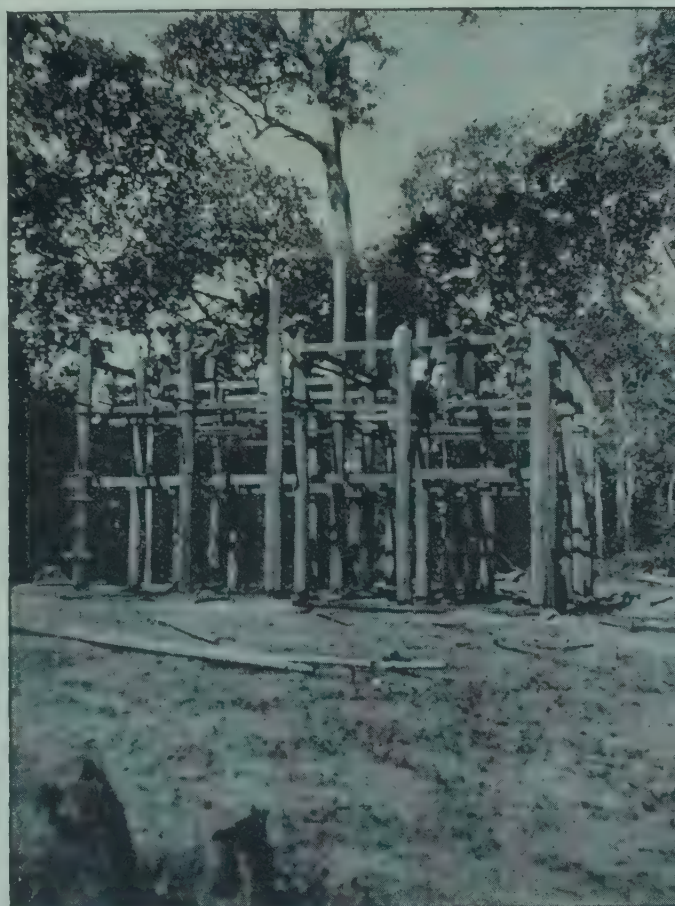


Fig. 3. Eighth day—shews the post plates and tie beams being put on.

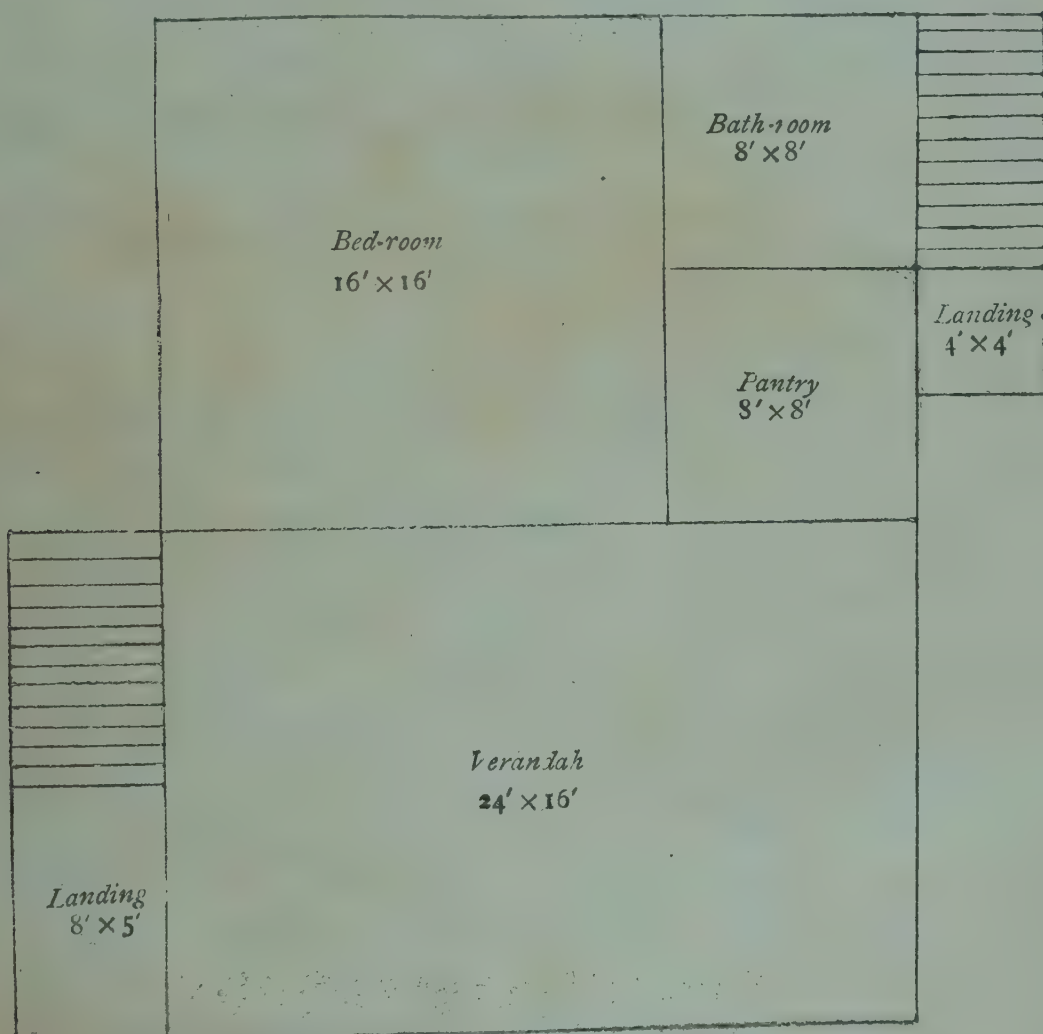
PRACTICAL ENGINEERING WORK AT THE BURMA FOREST SCHOOL, PYINMANA.

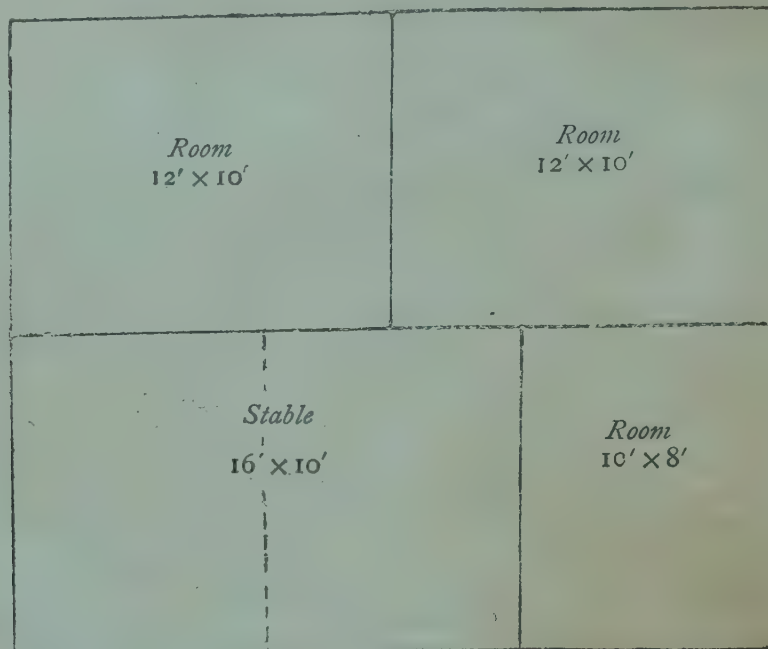
BY A. J. BUTTERWICK, P.F.S.

1. The attached series of photos (Plates 35 and 36) will be found of interest, as they show that the practical side of engineering is not forgotten in the Burma Forest School, Pyinmana.

A third class forest bungalow, according to standard plan, was required by the Pyinmana Forest Division at a camp called Zalokkyi, and the senior students of Forest School were asked to build the main building and servants' quarters. A plan of each of these is given below :—

Plan of Main Building (Scale $\frac{1}{96}$).



Plan of Servants' Quarters (Scale $\frac{1}{96}$).

2. Work was commenced on the 28th January 1918, and both buildings were completed on the 2nd February 1918. Not counting Sundays, there were thus altogether thirty working days. On account of illness, etc., a daily average of 28 students worked on the buildings. The hours of work were from 7 to 11 in the mornings and 4 to 6 in the evenings. Work on the main building only was done for the first eight working days, then on the servants' quarters only for the next three working days, and on both buildings simultaneously for the remaining nineteen days. With the exception of the clearing and levelling of the site, and the roofing of both houses, the students did the entire construction of the buildings themselves, including the pegging out and the digging of the post holes. The timber mainly used in both buildings was *Thitya* (*Shorea obtusa*), and on account of the unusually large amount of cup shakes, heart cracks, and other defects, which these logs were found to have, the posts, planks, and scantlings were found to be very unsound and liable to warp very badly. Great difficulty was accordingly found in making the different parts of the buildings fit strongly and accurately.

3. That this actual construction of buildings, bridges, and roads is of paramount importance in any instruction in engineer-

ZALOKKYI FOREST REST-HOUSE, MAIN BUILDING.



Fig. 4. Eighteenth day—shews the hip rafters being put up.



Fig. 5. Twenty-first day—shews the purlins being put up.



Photo.-Mechl, Dept., Thomason College, Roorkee.

Fig. 6. Twenty-fourth day—shews the wagat roofing being put on.
Some students are laying the floor planks on the joists.



Fig. 7. Thirtieth day—shews the completed main building

ing, has been found from experience by the writer. There are a thousand and one things which one learns during the construction which can never be obtained from even the best text-books. Even the apparently simple operations of pegging out the plan of the building or bridge, and putting in the posts, some of which are well over 30' long, are much more tricky than one is apt to think.

4. The erection of a building or bridge has, therefore, been entered as one of the most important items in the curriculum of the Burma Forest School. In this connection it will be interesting to note the different important engineering works done by the students for the last five years:—

In December 1913. Made 81 reinforced concrete boundary pillars for the elephant fodder reserves at Yeni.

In February and March 1914. Erected a students' barracks 120' × 20' at Ainggyé.

Lecture term of 1914 (Saturdays). Erected a wire-rope suspension bridge 200' long for foot traffic over the Ngalaik Chaung at Pyinmana.

In February and March 1915. Constructed a second students' barracks 120' × 20' at Ainggyé.

In July and August 1915. Constructed a mitre joint, or straining beam, trussed bridge 20' span at Ainggyé for cart traffic.

Lecture term of 1915 (Saturdays). Made over 200 reinforced concrete blocks for a well for the School recreation ground; also put up a rough single lock bridge 35' span for foot passengers in the School compound.

In February and March 1916. Constructed a N trussed bridge of 40' span over the Thetha Chaung at Padaukkon, the biggest scantling used being 15' × 9" × 3"; also made at the same place, a simple girder bridge 12' span over the Gwedauk Yo. Both the above were for cart traffic.

In February and March 1917. Constructed a simple girder bridge of 24' span for carts over the Monhnit Chaung at Monhnit.

In February and March 1918. Put up a third class forest rest-house and servants' quarters at Zalökkyi.

Besides the above major works, the students have done the usual road alignment and road construction, including the erection of sleeper and other culverts, Irish bridges, and pole drains.

SIMUL PLANTATION IN JHUMS IN ASSAM.

BY R. N. DE, PROVINCIAL FOREST SERVICE.

1. Simul (*Bombax malabaricum*) is found abundantly in all the alluvial formations of the Lakhimpur and North-East Frontier Districts. It is a pioneer tree and comes up plentifully in alluvial formations in these parts. Due to the luxuriant growth of the evergreens that come up afterwards on those formations, the subsequent regeneration of Simul is altogether stopped: the seeds either do not reach the soil at all, or if they do, can neither germinate nor grow under the evergreen cover. The result is that we have huge Simul trees here and there in these forests, surrounded by evergreens, with no Simul reproduction at all.

2. In the districts above-mentioned, there are altogether five saw-mills working for making tea-boxes. Of the tea-box trees, Simul is the most abundant and important one, though other soft-wooded trees are also used. As the saw-mills are gradually working Simul, there will be a total absence of this tree in these parts, unless it is propagated. Hence the necessity of plantations to continue the supply of Simul.

3. The Simul may be put to other uses in the near future beside making tea-boxes. Recent experiments on its suitability to make cold storage vans have given favourable results, and it has been found to be a better insulating material than even cork; in the vans under experiment the insulating material used was Simul. The temperature of the vans was reduced by ice from 90°F. to



Photo.-Mechl. Dept., Thomason College, Roorkee.

Terminalia myriocarpa 46'-4' in girth round buttress,
killed by fire, in burning *jhums*.

42°F. in 24 hours. The heat leakage or rate at which the temperature of the vans increased on the exhaustion of the ice supply was 1°F. in 4 hours (*Indian Daily News*, 16th October 1917).

4. In order to reproduce Simul, attempts were first made to plant it in lines, in grass areas. The plants were put out from nurseries, but the method was expensive. Continual cutting back of the grass was necessary, as otherwise the young plants were choked; in addition, a large amount of damage was done by wild elephants, which, finding a cleared line, promptly used it as a path with disastrous results to the Simul. Broadcast sowing was also attempted without success.

5. In these parts there is a jungle tribe called the "Miris" who practise jhumming, *i.e.*, shifting cultivation. They clear jungle at the beginning of the hot weather and then set fire to it. This firing is responsible for the death of many large forest trees. (Plate 37 shows a hollock tree—*Terminalia myriocarpa*—46' 4" in girth killed by fire.) They cultivate the "jhums" for two successive years, rarely three if the soil is exceptionally good, and then let it lie fallow for about ten years, after which they come back again to "jhum" the same area. The staple product they cultivate is rice. Advantage is taken at present of this practice to spread Simul.

6. The system adopted is as follows :—

Early in June or July varying according to the time when the Simul seed ripens, it is collected by the Forest Department and distributed to the villagers who, at this time of the year, sow rice in their newly cleared "jhums." Before the rice is sown they have to put up stakes in their "jhums" at 26' × 26' and then the rice is sown with the Simul seed, the latter at each stake. Sometimes the rice is sown before the Simul. Five to ten seeds are put at each stake; this is done to be perfectly sure that there will be no failure. In some cases the staking is done under the supervision of Forest Officers, but in the North-East Frontier District, the "Miris" do it themselves under the instruction of Forest Officers, as the Forest staff is insufficient to do the staking in a number of villages, scattered over a considerable area. If the seeds are good, they germinate

freely within six or seven days. Though Simul does not grow so quickly as the rice plant, it is not at all injured by the latter. If, at any stake, no Simul seed has germinated, seedlings are transplanted from those stakes where there are more than one.

7. As the transplantation is carried on, only the best seedling is kept at each stake and the rest are transplanted if necessary, or removed. After the rice has been cut, the area is cleared and mustard, rye, potato, etc., are grown in the jhums. By this time the Simul plants are 1'—2' high. Next year in the rains, the rice is sown again after clearing the area of weeds, and this rice is weeded once or twice during the rains. In the rains, the Simul plants grow very vigorously, some of them attaining 6' in height. Having received such careful tending from the very start, no amount of weeds and fast growing shrubs can hinder their growth and by the winter of the second year most of the plants are 8' and over in height; Mr. Jacob, Deputy Conservator of Forests, has measured seedlings which have attained 15' in height in their second cold weather. The Miris usually abandon their jhums at the end of the second year after growing mustard, etc. The plants now need no looking after and can fend for themselves, but if the land is cultivated for the third year, the plants do still better. The Miris can grow crops underneath Simul without difficulty, as it has a very light crown.

(Plate 38 shows a Simul jhum in its second cold weather.)

8. As from its habit, Simul does not grow any more branchy when isolated, and as the height growth of this tree is not appreciably stimulated by growing the plants closer together, thinning and cleaning operations are unnecessary. It was found that when planted 12' x 24,' branches were interlacing by the third year; this is why plants are put in 26' x 26'. Much knowledge has yet to be gained as to the best distance at which plants should be spaced. Sample plots have been laid out in the Lakhimpur District to ascertain the rate of growth of Simul.

9. The Miris of the North-East Frontier District who plant Simul in their jhums are given one first-class tree free for a dug-out, per house, once in four years and are paid Rs. 4 per 100



Photo - Meehl. Dept., Thomason College, Roorkee.

A *Simul'jum* in its second cold weather.

seedlings which are 8' or over in height, in the cold weather of the second year when the counting is made. One bola tree (*Morus* sp.) is also given free to every 20 houses for making oars. In the Lakhimpur District, Miris are allowed the privilege of "jhumming" inside the Dibru Reserve, the area, where jhumming is to be permitted, being selected by the Forest Department. They are not entitled to any trees and no payment is made to them, as the jhumming inside the Reserve is itself a great concession; the more so, since they have nearly exhausted all forest lands near their villages.

10. The system is working quite satisfactorily in Lakhimpur and the North-East Frontier Districts, where many areas formerly unstocked or stocked with useless species are now getting filled with promising Simul plants. In the North-East Frontier District there were some 450 acres under Simul in 1916-17. Many seedlings have been damaged and even killed by floods during the rains in the low-lying areas. The low-lying "jhums" have, therefore, been excluded as unsuitable for Simul. It has been estimated at present that Simul will take 25 to 30 years to attain 6' girth, which is a suitable size for conversion. Some saw-mill managers are of opinion that 4' girth is more convenient for making tea-boxes in their mills, but the wood of such trees is likely to be spongy.

11. Up till now no serious damage has been done to the young seedlings by animals or by insect pests, but the plants are freely browsed by deer, etc. The writer has, moreover, seen cases of damage by Longicorn larvæ, and has sent specimens to the Forest Zoologist for breeding and identification.

FLOWERING AND AFTER OF *BAMBUSA ARUNDINACEA*.

BY K. GOVINDA MENON, CONSERVATOR OF FORESTS, TRAVANCORE STATE.

All the authorities are more or less agreed with regard to the periodicity and gregarious flowering of *B. arundinacea*. Gamble says with regard to *Bambuseæ* that "in a few species they come annually, in most they come at long intervals and then all the

clumps in a locality flower together and seed and die." Bourdillon divides bamboos with regard to their habit of flowering into three great classes, *viz.*, (a) those which flower annually or nearly so, the flower panicle terminating leaf-bearing culms; *e.g.*, *Ochlandra Rheedii*; (b) those which flower gregariously and periodically, all culms of one clump and all clumps in one district flowering simultaneously. The culms die after ripening their seed and usually the underground rhizome also dies; *e.g.*, *B. arundinacea*; and (c) those which flower irregularly, one or a few culms in one clump or a few clumps in one locality flower together, while at other times there is a simultaneous flowering all over the district; *e.g.*, *D. strictus*. Periodic and gregarious flowering of *B. arundinacea* is hence an established phenomenon.

In 1918 March—April, most of the bamboos of the above species in the Thekkadi leased forests of the Tunacadavu Range are reported to have flowered and seeded. In the adjoining private forests no bamboo has flowered at all. In the Cochin State Forests which touch the leased forests on the western side one solitary clump of *B. arundinacea* flowered and seeded. No other clump has seeded anywhere close by though the whole forest is full of bamboos. The solitary clump which flowered is about two miles as the crow flies from the leased forests where the bamboos have flowered, and this clump was bodily pulled down by wild elephants and the panicles eaten up. After the advent of May showers, small leafless shoots came up from the rhizome of this clump and all these shoots ranging from 1' to 3' in height flowered and seeded by the end of June.

Two conclusions are deducible from the above:—The flowering of *B. arundinacea* is not necessarily gregarious but may be solitary. (2) The reserve materials in a flowering clump of *B. arundinacea* left behind in the rhizome, if any, are not fit to be utilized for developing leafy shoots but for giving rise to shoots which must at once flower and seed; possibly due to the absence of an enzyme required to reconvert the reserve material into a suitable form for the production of leafy shoots. But this requires further investigation.

"MI-DO:" THE TALE OF A HAING.*

BY J. D. C.

"SIR,—I was out searching for my buffaloes this evening when I met the 'haing-gyi' who at once chased me and I only escaped by climbing a tree and waiting till he moved off." The words were spoken in Burmese by an elderly contractor employed at the time in dragging logs to a forest saw-mill near by. I was disturbed in a deck chair gazing into a camp fire, thoughts thousands of miles away in the West Country as they are apt to be at this time of day or rather night when one feels fed up with one's own society after a long spell in the forest. By the light of a half moon to go out after a rogue elephant held no attraction for me, so I told the contractor to go out early the following morning to look for tracks; and if he found them or the animal reasonably near, to come back and let me know. I had first heard of this haing when I came to the division nearly five years ago, since when he had, to my knowledge, killed three people, chased the D. F. O. when riding along a cart-track narrowly missing the breakfast coming on behind, charged another forest officer in spite of three dogs and several camp followers being with him, and had frequently delayed dâks by holding up the runners. With the local Burmans he had a very evil reputation as, in addition to killing the aforesaid solitary travellers, he was in the habit of lying in wait for carts and people returning from 'taungyas' with paddy and other produce, frightening the people who immediately abandoned their loads whereupon the haing would help himself at leisure to the luxuries thus within his reach. He was said to be peculiarly partial to tomatoes, and once walked through a camp helping himself to these and other vegetables without doing further damage. For years he had been regarded as a dangerous rogue and many have been the attempts on the part of forest officers to bag him. On one occasion he is alleged to have been hit by a charge from a 4-bore which bowled over the operator but

*Haing is the Burmese term for a "makna" or tuskless male elephant.—[HON. ED.,]

not the intended victim, and, in spite of numerous other undoubted hits, he seemed to bear a charmed existence. This fact must be largely attributable to his habit of never staying for any considerable length of time in one place, so that if heard of at a particular spot one day he was quite likely to be ten miles away by the next. All sorts of damage was put down to his account and, whenever any unusually large tracks were seen, it was always presumed he had made them.

However, haing or no haing, my sleep was not disturbed that night. Nor the following day did I think of him, except once whilst out at work hearing a crashing in the undergrowth I realized I had no gun, only to find that it was my terrier chasing buffaloes. At half past twelve when I had finished breakfast and was just about to settle down in a comfortable chair to spend an hour grappling with home politics, the National Review as my mentor, up the verandah stairs walked the old contractor and I knew my hopes of a restful afternoon were no more. After tracking for most of the morning, he said he had located the elephant in some dense evergreen not more than a mile away. As I didn't know the man, I decided not to entrust him with a spare rifle, so took my .450 only. The one mile turned out to be three before we got on to the tracks in cool shady forest along the head-waters of a nearly dried-up stream. Passing on the way several field huts and saw-pits, I noticed the retinue of followers steadily growing but refrained from saying anything until we were on the tracks. The old tracker had seen them too and without any hint from me now turned round, picked out one with a good knife, told him he could follow and the rest to sit down and wait till they heard a shot. From this moment on he went up in my estimation, and later I found out he was an experienced elephant tracker. In about half an hour, after getting through some bad places including cane-brake fairly quietly we heard the animal smashing bamboos close ahead. Tracking then became exciting work, we being on the side of a steep slope with the elephant at the bottom about 100 yards further along. The slope now became much steeper and was covered with thorny undergrowth as well

as dead leaves which are difficult enough to get quietly over without other obstacles. The tracker was making as much noise as I was, perhaps more, so I pulled him up but he merely said it didn't matter as the haing was not afraid of people. I explained to him that that might be quite true if it was the big haing, but I wanted as good a shot as I could get and was not at all keen on going further than was necessary nor did I want a shot at a charging beast in dense jungle. A short way back I had seen fairly clear tracks in the sandy stream-bed and they did not appear so enormous as on other occasions. Being told I would not shoot unless it was the big haing, the man didn't mind at all as he was quite positive of the animal's identity. What wind there was seemed to be downstream, so we climbed the slope we were on, dropped a few feet the other side and went on fast. Then having gone just about far enough to head the animal off, we crossed over the top slowly and got down quietly to within about 40 yards of where bamboos were still crashing. I now got a glimpse of the tail which was a broken off stump with no sign of a brush, and at last I felt quite sure it was "Mi-do" (Burmese for "Short-tail"). Shortly before I thought I had heard the ominous clinking of a chain and the unpleasant prospect flashed across my mind of walking up to a dead tusker with a big C* or SB on the rump and a few feet of tethering chain on one leg. My provident fund would have been required in such an event. Again the tracker cheered me up by saying he could hear no chain and that it must have been some bird. One has always to bear in mind, however, that even the best Burman tracker is out for meat rather than sport or rupees. Having seen the stump of the tail as already mentioned, I had no further doubts. Both of us now got up to a tree some ten yards nearer and then I had to wait several minutes, probably not as many as they seemed, before getting a chance at a head or ear shot. I got the latter and he staggered as soon as I had fired and began to fall slowly, but I was taking no risks with a beast of his reputation and hit him a second time in nearly the same spot before he rolled over. He struggled on

* Note.—Timber firms in Burma invariably brand their working elephants.

his back with his four legs kicking wildly in the air, lashing his trunk about furiously, gurgling and taking very long deep breaths. He was an extraordinary sight in this position appearing even more huge than when on his feet. The noises and lashing of the trunk continued, so I crept up closer to put him out of pain, but on seeing me he made a mighty effort and righted himself. Two shots more made him sink slowly into the crouching position that trained elephants assume before being loaded with baggage and, in this position, he remained motionless, the mass of his body completely hiding one hind leg from view. He was in splendid condition, being paddy-fed as one of the Burmans remarked, and measured 4 ft. 6½ ins. round the fore-foot which would make him just over 9 ft. in height (the biggest baggage animal in this division measures 7 ft. 6 ins.). After I had shot him I felt quite sorry at having deprived such an immense and magnificent beast of life. The Burmans did not feel the same, crowding on to his back like a lot of children in the gayest of spirits and few failed to inform me he was a man-killer.

The camp spent the whole of the next day cutting up the carcase, villagers flocking in from miles around assisted in the work and there were no coolies for the saw-mill nor sawyers for the saw-pits that day. The old Burman estimated that 150 villagers carried off at least 20 pounds of flesh apiece: delighted as they were at getting rid of a much-feared enemy, the prospects of a flesh feed caused them just as much pleasure. Elephant tail makes good soup; the meat is like coarse and rather flavourless beef but edible as a change from the eternal chicken. Of the enormous quantity of flesh on an elephant, not a particle is wasted by the time the cutting up is finished. It is all carted or carried away within twenty-four hours, and is afterwards cut into small strips and hung on lines in the sun to dry. Though several men were left to camp near the carcase overnight, the guard was not efficient, the trunk having been hacked off and stolen before daylight. The finger at its tip is invaluable in Burmese medicine. Getting the flesh out of the feet is tedious business and hacking through the bone with an axe quickly destroys all edge. As a

temporary preservative I had the cleaned feet stuffed with a mixture of wood-ash and sand.

The fearless manner of the old tracker armed only with a knife struck me as admirable: any Government reward on the haing I am recommending be paid to him.

FIRST MEETING OF THE BOARD OF INDUSTRIES, INDUSTRIES SECTION, CAWNPORE.

After the reorganization of the Board of Industries the first meeting of the Industries Section was held at Cawnpore on the 27th July 1918.

Among other matters, the Board considered the proposal of the Director of Industries regarding the working of the Central Emporium, Cawnpore the appointment of a die-sinker and tool maker—and the utilization of Rs. 10,000 sanctioned for experiments in tannin and other dye-extracts. The following subjects were recommended for the award of State Technical Scholarships for the year 1919 :—

- (1) Wood-distillation.
- (2) Electrical Engineering.
- (3) Dyeing of textile fabrics.

CORRESPONDENCE.

TO THE HONORARY EDITOR, *Indian Forester*.

A NEW SYSTEM OF TIMBER EXPLOITATION.

DEAR SIR,—With reference to the extracts from the *Pioneer* dealing with a new system of timber exploitation appearing in your issue for June, I should like to point out that Mr. Parnell's estimate of the yield of deodar trees is entirely wrong. A reference to my yield table for deodar, a copy of which I forward herewith, will show that a deodar of quality I, 30" in diameter, yields 109 cubic feet of sawn scantling and that not until a diameter of 39" is reached does the yield amount to 150 cubic feet which is still short

of Mr. Parnell's 50 B. G. sleepers. The yield of trees of quality II and III is, of course, considerably less so that even the revised estimate of 40 B. G. sleepers as the average yield of a first class tree 30" in diameter and over is far in excess of what will actually be obtained in practice.

C. G. TREVOR,
Deputy Conservator of Forests,
Kulu Forest Division,
Punjab.

Yield table for Deodar.

Diam.	Quality I over 120 ft.		Quality II 90 ft.—120 ft.		Quality III under 90 ft.		Kulu average.		Volume of trees adopted for cal- culation of the yield.	
Class.	Logs. c.ft.	Scants c.ft.	Logs. c.ft.	Scants c.ft.	Logs. c.ft.	Scants c.ft.	Logs c.ft.	Scants c.ft.	1" classes.	3" classes.
24	140	68	100	56	78	42	87	49	85	95 c.ft.
25	158	75	109	59	83	45	96	54	95	
26	170	82	118	63	90	48	107	58	105	
27	183	89	123	67	97	51	116	64	115	125 c.ft.
28	191	96	135	70	104	55	127	70	125	
29	200	102	144	74	111	59	136	75	135	
30	207	109	153	77	119	63	147	81	145	157 c.ft.
31	215	115	162	81	127	68	158	88	155	
32	223	120	170	86	134	72	172	95	170	
33	229	126	178	91	142	77	185	103	185	198 c.ft.
34	234	131	186	95	150	82	198	110	200	
35	238	136	192	100	159	87	210	117	210	
36	243	141	201	106	168	92	224	125	225	257 c.ft.
37	248	145	209	111	177	98	236	133	235	
38	253	149	217	118	186	104	248	140	250	
39	258	153	226	127	196	110	256	150	260 and over.	260 c.ft.

Note.—(i) Quality I over 120 feet height.

II from 90 feet to 120 feet.

III under 90 feet.

(ii) Volume of logs = all exploitable produce and may, therefore, be used as volume of trees.

(iii) Kulu average based on measurements of 7,700 Kulu trees exploited during last 20 years.

(iv) Enumeration figures converted into volume according to figures for 3" classes. In felling against the prescribed yield volume according to 1" classes will be taken.

(v) Standard loss in converting logs into scantlings 45 per cent.

Addendum to Standing Order No. 25.

The yield table for deodar (I class trees only) is forwarded herewith for information and the figures contained therein will now be brought into general use throughout the Division.

2. In marking trees for the P. W. D. or District Board the table, according to quality classes, will be used and trees marked in accordance with the number of scantlings required as given in the yield table. Similarly, in the case of trees felled for departmental works, the table according to quality classes may be used.

3. In all cases of the sale of trees standing, the figures adopted for the calculation of the yield in the revised working-plan will be used.

4. The standard loss in converting logs into scantlings is 45 per cent. Objections will be raised by the Divisional Office in all cases where this loss in conversion has been exceeded unless a satisfactory explanation is submitted to account for such excess loss.

5. Every official of the rank of Forester and above will enter this yield table in his pocket-book and will use it.

Deputy Conservator of Forests,

Kulu Division.

14th August 1916.

EXTRACTS.

BURMA FOREST SERVICE.

TO THE EDITOR, "RANGOON GAZETTE."

SIR,—From the Burma Quarterly Civil List ending July 1918 it will be seen that owing to the war, eleven deputy commissionerships and eleven district superintendentships of police are now held by provincial service men, whereas the pre-war regulated figure was two for each service. Similarly in the judicial branch, in the P. W. D., in the medical service, and in the educational department, all the appointments rendered vacant by the departure of the imperial service occupants on active service have been filled up by the promotion of provincial service men. Further, daily as more imperial men are being called out on military service, more provincial men are being promoted to the vacant posts. A large percentage of these promotions have been given to Burmans too. The only service in which this liberal and justifiable procedure has hitherto not been followed is the forest service in Burma, and Burma only ; for, in the other provinces in India, provincial forest men have been freely given the vacant charges previously held by imperial men. A fairly large percentage of the latter have gone on military service, and many more are about to go. Also recruitment to that service from home has ceased for some time now. In spite of these facts, the provincial forest men in Burma have been given only one additional divisional charge since the war started. The forest powers that be, rather than give the provincial men the vacant charges, have doubled up the divisions, and placed two under one divisional forest officer, generally an imperial man. For example, the D. F. O., Pakokku division, is also managing the Minbu division, the D. F. O., Katha division, is similarly running the Myitkyina division as well as his own, and the personal assistant to the conservator of forests, Pegu circle, has been given, besides his onerous duties in the secretariat, the control of the Insein division as well. The same powers that made these appointments stated in every annual report before the war that the divisions in

Burma were much too large, that the D. F. O.'s were understaffed and overworked, and that the work was rapidly increasing in volume annually. It seems very paradoxical that now, although the staff has been very heavily depleted owing to the number of men on military service, and although the work has increased three-fold with the supply to the military of timber, these same forest powers are placing two large divisions under one officer with a smaller staff. This one officer, however energetic and capable he may be, cannot possibly run two divisions with their concomitant offices efficiently, and it means one of two things; either one or other division is being totally neglected, and the subordinates and clerks in it are getting very out of hand; or both divisions are being insufficiently controlled. Incidentally these dual charges are costing Government a tidy sum of money, for each officer who holds such a charge gets a sum of Rs. 100 added on to his pay. Further, it also means a lot of time wasted, as the same officer has to travel about needlessly from one head-quarters to another. If eleven provincial men, the most of whom are Burmans, are considered fit by the Local Government to be deputy commissioners of most important districts, surely there must be more provincial forest men at present in subordinate charges who could well hold charge of forest divisions. There is not a single Burman in charge of either a forest division or even of a forest sub-division. Looking up the same Civil List, it will be seen that there are nine extra-deputy conservators of forests, with services varying in length from 19 to 26 years, holding subordinate charges. There are also several extra-assistant conservators of over 15 years' service, who are yet in subordinate positions, whereas their more fortunate forest college confrères, serving in India, have long been holding divisional charges. Regarding the E. D. C.'s, the following extract taken from the resolution of the Government of India in the department of revenue and agriculture, No. 17F. 77-33, dated Simla, the 23rd June 1911, will be of some interest:—

2. (ii) Extra-Deputy Conservators.—“No officer may be promoted to the rank of E. D. C. unless the Local Government considers him fit to hold a major charge; and except for special

reasons an E. D. C. should be actually placed in a charge classed as major."

As the above-mentioned nine E. D. C.'s have been promoted to their grades by the Local Government, it follows that the Local Government must have considered them fit to hold major charges; and, according to the very clear orders quoted above, they should be given major charges, especially now when there are a lot of vacancies. No one can learn to control and administer unless he be given a good early chance to do so; and no one who has not been given such a chance, should be condemned as unfit. Also any man, however able he may be, if he be kept down in a subordinate, irresponsible capacity for a very long part of his early career, will lose that sense of responsibility and self-confidence which is a *sine qua non* for efficient control and administration and he will never be a success in a superior appointment. In view of the excellent, broad-minded, and statesmanlike speech delivered by the Lieut.-Governor in the recent durbar held at Rangoon it is to be earnestly hoped that the egotistical and parochial policy which appears to have hitherto characterized the administration of the forest service (and no other) in Burma, will be abandoned and every encouragement and advice be given to the provincial men to enable them to become efficient administrators. Also this encouragement and advice should be freely given as well to the younger promising provincial forest officers, as they are in the most important periods of their careers.

Yours etc.,

NOUS.

[*Rangoon Gazette.*]

[We understand that there are 22 Provincial Forest Officers who joined the service before October 1904 in the Civil List referred to. Of these 11 are now in charge of divisions, one is at the Pyinmana Forest School, one is in the Andamans, one is on leave and eight are doing Assistant's work.—HON. ED.]

FOREST GRAZING AND THE NELLORE
" KANCHA " SYSTEM.

BY CECIL E. C. FISCHER, DISTRICT FOREST OFFICER, NELLORE.

THE grazing of cattle in the forest is admitted to be a detrimental practice from almost every standpoint. Apart from the injury to the forest itself, and thereby to the dependent interests, it has all the objections of promiscuous and communal grazing.

These facts and their remedies have been urged for a long time by foresters in India, but very little weight has been given to their opinion which are generally looked upon as highly coloured, and biased. It is only recently, at least in the Madras Presidency, that steps towards an intelligent policy of improvement have been taken. How far this has come about through the insistence of forest officers it is difficult to judge, but it seems clear that more attention is accorded to the opinions of others on the subject. It will be useful, therefore, to quote the words of an agricultural officer who has expressed the gist of the matter more eloquently than I can hope to do. In his report on his Cattle Survey of the Madras Presidency, Mr. H. C. Sampson wrote: "It is a noticeable fact that the nearer cattle are to the forests, the more degraded the type. Here one sees all the evils of mixed grazingForest grazing is always a serious menace to the forests and not only to the forests but to the water-supply of wells and tanksGrazing and forestry are, and must be, at variance ; for, as the forest canopy increases, the grass tends to disappear and the simplest way of lessening the shade and increasing the grass is by forest fires."

It is not necessary to dwell further on either of these two aspects of the evil.

Unfortunately, in most parts of India, at all events practically throughout Southern India, it has been customary for the people to send at least their inferior cattle to graze in the forests, and no sudden stoppage of this practice could be contemplated.

In some parts of the world some kind of compromise has been arrived at and a silvo-pastoral system has been evolved

under which the growing of trees and the production of fodder-grass go on side by side. But it is only a compromise and, moreover, premises the most favourable conditions of climate and human co-operation. All these circumstances are absent in India, nor could even the human co-operation be hoped for short of a considerable period of education.

In order to devise remedial measures it is necessary to understand thoroughly the routine of the objectionable practices. Where some attention has been paid to the breeding of cattle, the breeders themselves have introduced restrictions. There the better class of cattle are stall-fed, or at least carefully segregated and grazed on the land in numbers not exceeding the feeding possibility of the area. In other localities, and in even these as far as the excess cattle maintained for manure or for the prestige of ownership is concerned, there is no such restriction. The number of cattle is far in excess of that which can find sustenance on the land. Large herds have to find what food they can, with the deplorable results inseparable from communal and excessive grazing.

To add to the disastrous position, that unsavoury enemy of vegetation, the goat, until recently was rampant. It is only within late years that this animal has been excluded altogether from Government forests.

The remedy for this state of affairs lies clearly, firstly, in the reduction of what may be termed the "drone" cattle to reasonable limits and the segregation of the different classes so as to avoid the evils of promiscuous breeding; and, secondly, in providing ample fodder for all.

There actually has existed from before the days of the British occupation an indigenous practice of this kind in the Nellore District, and this has given a direction for the policy of the future.

The Nellore District forms a comparatively narrow belt along the Bay of Bengal stretching for about 140 miles, starting about 40 miles north of the presidency town. On the west it is bordered by a low chain of mountains known as the Veligondas. Between this range and the sea, a distance of 50 to 60 miles, spread plains dotted with hills of gradually diminishing elevation and furrowed

by numerous rivers and streams. Near the coast and adjoining the many tanks, there are stretches of rich arable soil, but by far the greater portion of the area consists either of ocean sands, dry gravelly or quartzose soils of small fertility. A fair proportion, including most of the hillocks, is occupied by so-called forests. These are of the poorest type and are made up mostly of thorny shrubs such as *Carrisa spinarum*, *Randias*, etc. They present ample evidence of the goat-browsing, over-grazing, and ruthless hacking of the past. Such are the areas in which the forest officers, until recently, have been inhibited from imposing salutary restrictions in the direction of limiting the number of head to the available supply of fodder, with the result that the areas have been further degraded instead of being improved after being brought under forest reservation.

It is perhaps a matter for surprise that this district is the home of the famed Nellore or Ongole breed of cattle and that so fine a breed could be raised alongside the desolation I have attempted to depict. But the best class of cattle are bred mostly in the coastal tracks where they are either stall-fed, grazed on the fields when lying fallow, or pastured on private lands earmarked for the growing of fodder under the strictest surveillance. It is only the miserable excess cattle, and of course the goats, that are responsible for the injury stated.

The areas reserved for the better cattle are enclosed within fences and are known locally as *kanchas*. They are given a period of rest during part of the year and only a strictly limited number of cattle is admitted at other times. The period of rest coincides with the time when, after the break of the south-west monsoon, the new grass is growing and the fields are not yet under crop, so that the latter are available for pasture. By the time the cattle must be driven from the fields the *kanchas* are ready for them, to be closed again when the stubble left on the fields after the harvest invites them afresh.

Owners of such grazing blocks who are in a position to admit the cattle of others demand high rates for the privilege. The fallow areas in the wet land tracts are insufficient for all the cattle

when the fields are closed to them, and there sets in then a temporary emigration towards the hills, the beasts returning only after the harvest.

This is the "Kancha" System which, during the past three years, has been extended to practically all the Government forests in the plains of the district. For climatic and irrigational reasons the slopes of the Veligondas have not been included in the scheme, the hills are closed to grazing and the cutting and removal of grass alone is permitted. The plains forests have been divided up into blocks of convenient size, varying from 60 to 3,000 acres. Each block or *kancha* is put up to auction in May for the ensuing grazing season at an upset price of 4 annas per acre. As far as possible the village limits are adopted as the boundaries of the blocks so as to induce the village as a whole to purchase the lease for the use of the village itself. Here and there speculators take up a block or two with a view to making a profit on the migrant herds from the wet belt, the owners of which are willing to pay a comparatively high rate for ensured and safe pasturage of their valuable cattle.

The *kanchas* are handed over to the purchasers on the 1st July although they remain closed to grazing for another $2\frac{1}{2}$ to 4 months according to seasonal variation. When grazing starts, the incidence is limited to one head of horned cattle (bulls, bullocks, cows, and buffaloes) for every two acres or one sheep per acre. It will be seen, therefore, that the grazing costs at least 8 annas per head of horned cattle or 4 annas per sheep. The majority of the *kanchas* sell for 4 annas per acre or a trifle more, but a considerable proportion, owing to local conditions and competition, fetch a good deal more, culminating in one instance at Rs. 4 per acre. This rate is in extraordinary contrast with the nominal fee of 3 or 4 annas per cow or bull, 6 annas per buffalo, and $1\frac{1}{2}$ or 2 annas per sheep, which was the grazing fee for the whole 12 months under the old system of unlimited grazing on individual permit.

From the date of opening the *kanchas* may be grazed upon until the end of April, after which they are closed again just before

the first premonitory showers before the monsoon are expected. Sheep are not admitted simultaneously with horned cattle, but only after the latter have quitted late in the season.

An important feature of the system lies in the fact that the protection of the *kancha* against malpractices of all kinds is left almost entirely to the lessee, who is directly responsible and may be fined or even have the lease cancelled should he default in this matter. The lower subordinates of the Forest Department are forbidden to interfere in any way, except to assist at the direct invitation of the lessee.

With some of the blocks, in addition to the area open to grazing, the lessees undertake the protection of adjoining areas that are closed for regeneration or for other reasons. For the successful protection of these closed areas the lessee is permitted to cut and remove grass or in lieu is entitled to a rebate of one anna per acre so protected.

In recognition of their efforts the lessees whose protection has been effective, receive rewards of from 5 to 10 per cent. of the purchase price of the block according to the degree of protection extended, and the most meritorious are awarded silver medals in addition.

The lessees are provided with printed permit forms. No cattle should be found within the block without a grazier in charge and the latter must be furnished with a form signed by the lessee covering the number of animals in his care.

The eventual aim is that the leases should be taken up by the village as a corporate body and managed by an elected council or *panchayat*. In this way the people will be invested with a measure of local self-government and become the protectors of their forests and their own interests therein. Without such co-operation protection would be hopeless.

The forests open to grazing under this system are not necessarily devoted to grazing alone. Many are being worked simultaneously for the provision of fuel and small timber on a rotation by small areas. Each annually worked area, or *coupe*, is closed for

a period of ten years, following the year of felling, to all grazing or extraction. Each *coupe* is surrounded by a fencing of dry thorns, which is constructed as the work of felling proceeds, so that the fence is complete by the time the produce has been removed. As a rule, it is these areas that the *kancha* lessees undertake to protect in addition to the block leased for pasture.

But little reflection will make it clear that the final word has not been said when we have reached the stage described hitherto. We have seen that intensive grazing and the existence of forest growth on the same area are incompatible. Excessive grazing means the more or less rapid extinction of the trees and shrubs, while the preservation and increase of woody growth entails the gradual diminution and disappearance of grass. It follows that the management detailed cannot go on in perpetuity and further steps must be taken if a permanent supply of fodder grass is desired. Such measures are actually contemplated. The plains forests of Nellore are being classified into fuel and fodder areas according to local demands, their actual condition, and the quality of the soil.

The management of the fuel areas will continue as laid down previously, but the fodder reserves are to be treated differently. Here annual *coupes* will be felled over, but the trees left as standards will be not more than 10 per acre and will be selected for the purpose of affording shelter for the cattle against sun and rain and regardless of their qualities as yielders of timber, fuel, or other produce, so that species generally considered as quite useless from a forest point of view—for example, *Dalbergia paniculata*—may well be selected so long as they have an ample crown. The fellings also will be so conducted as to discourage regrowth by coppice shoots.

Following on the felling, operations will be undertaken for the extraction of prickly pear and other thorny growth. In the following year the seeds of good fodder grasses will be sown in the areas thus freed of thorns. The *coupes* thus treated will be closed to grazing for a period of 2 or 3 years so as to establish thoroughly the new grass.

By these operations it is hoped to evolve pure grazing areas, studded with shelter trees, capable of supporting a much larger number of cattle than at present.

In this way it is expected to achieve the objects aimed at, that is to say, the reduction in the number of "drone" cattle by limiting the incidence of grazing and raising the fees so that the best cattle get the preference, and the provision of a sufficiency of fodder for the necessary cattle. Incidentally, it will secure to Government a financial return more in keeping with the benefits provided and lead to the improvement both of the pasturage and the yield in wood, all of which is in consonance with the motto of the Forest Department: *Meliora Speramus*.—[*Agricultural Journal of India*].

